FRENCH LIMITED SITE
CROSBY, TEXAS

Natural Attenuation Modeling Progress Report

4th Quarter, 1996

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Submitted to:

U.S. Environmental Protection Agency
Region 6
Dallas, Texas

December, 1996

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EXECUTIVE SUMMARY

Executive summary

Groundwater at the French Limited site was actively remediated from January 1992 to December 1995, successfully removing approximately 220 tons of hydrocarbons from groundwater. Modeling was performed in December 1995 to predict the natural attenuation of the remaining chemical species in groundwater at the site for ten years after shutting off the active remediation system, and to demonstrate that these processes would result in site cleanup criteria being met at and beyond the compliance boundary within ten years, in accordance with the Record of Decision (ROD) for the site.

This report presents the results of the October 1996 groundwater sampling. The analytical results indicate that the affected S1 and INT groundwater does not represent a threat to the public health or the environment: FLTG continues to control all property that currently contains affected groundwater.

In general, areas of affected groundwater coincide with areas of high TOC and low DO. *Therefore, enhancement of natural attenuation through passive oxygen addition would* be an appropriate response.

The 1995 modeling of groundwater flow and natural attenuation processes used Visual MODFLOW© and BioTrans©. This modeling was updated in December 1996. The flow modeling component was unchanged from 1995. Contaminant fate modeling used a revised version of BioTrans© (v. 1.26). The partition coefficient (K_{oc}) and solubility for total organic carbon (TOC) were modified to reflect changed recommendations by the BioTrans© authors and to obtain better agreement between model predictions and field observations. A "hybrid" approach, which takes all available groundwater monitoring data into account, was used for model starting conditions. Modeled groundwater chemistry after a one-year run agreed fairly well with October 1996 field sampling results.

The model was used to predict groundwater chemical distributions in the year 2005. The model predicts that benzene, 1,2-DCA, and vinyl chloride above MCL will exist in some areas south of Gulf Pump Road, predominantly in the INT unit. This prediction is strongly weighted by the higher TOC readings that were obtained during the October 1996 groundwater sampling event, and which were used to create the "hybrid" starting conditions for the main nine-year model run.

Both the October 1996 field results and the model predictions indicate that there are fairly well defined areas in which high TOC, low DO and currently elevated chemical concentrations may inhibit natural attenuation of those chemicals to below MCLs south of Gulf Pump Road. Therefore, an action plan is proposed in which oxygen and nutrient release compounds would be added to the appropriate areas of the INT unit. These compounds would be placed in slurry form in boreholes drilled into the INT unit.

SECTION 1.0

1.0 Introduction

Groundwater at the French Limited site was actively remediated from January 1992 to December 1995, using a combination of (1) conventional pumping and above-ground treatment, (2) enhanced flushing through pressure injection of clean water, and (3) accelerated in-situ bioremediation through addition of two electron acceptors - dissolved oxygen (DO) and potassium nitrate - to injection water. Active remediation successfully removed over 220 tons of hydrocarbons (as total organic carbon) from the aquifer.

The Record of Decision (ROD) for the site states:

> Groundwater recovery and treatment will continue until modeling shows that a reduction in the concentration of volatile organics to a level which attains the 10^{-6} human health criteria can be achieved through natural attenuation in 10 years or less.

Based on this requirement, the ROD, the Consent Decree, and the Remedial Action Plan (RAP) describe a two-phase aquifer remediation process consisting of the following two phases:

Phase 1 - active remediation
Phase 2 - natural attenuation

In December 1995, modeling was performed to predict the natural attenuation of chemical species in groundwater at the French Limited Superfund site for ten years after shutting off the active remediation system, and to demonstrate that these processes would result in site cleanup criteria being met at and beyond the compliance boundary within ten years, in accordance with the ROD. Demonstration modeling results were presented in the 1995 *Natural Attenuation Modeling Report*[1]. Because these results were consistent with the ROD requirements, active remediation was discontinued on December 15, 1995.

1.1 Conclusions of 1995 report

The 1995 *Natural Attenuation Modeling Report* presented the following conclusions and action plan items.

1.1.1 Aquifer remediation status

The modeling results supported the scheduled shut-down of active aquifer remediation on December 15, 1995.

[1] Applied Hydrology Associates, Inc. December 1995.

The modeling results were based on the aquifer status and conditions as of October 1, 1995; the actual shut-down of active aquifer remediation was scheduled for December 15, 1995, which allowed an additional 2½ months of active remediation beyond the modeling basis date.

1.1.2 Active remediation shut down

During the 60 days before the December 15, 1995, active aquifer remediation shut-down, the target S1 and INT zones were dosed with electron acceptors and nutrients. The active aquifer remediation was stopped on December 15, 1995, and the system was dismantled and salvaged. Selected progress monitoring wells were maintained and sampled on a regular basis to evaluate natural attenuation progress, as described in Section 12.3 of the *Site Closure Plan*[2].

1.1.3 Phosphate dosing

Groundwater samples from monitoring wells at the French Limited site showed generally low phosphate concentrations, ranging to non-detectable. Phosphate presence was considered essential for microbial metabolism and, therefore, for bioremediation progress. However, non-detection of phosphate did not necessarily indicate that there was no phosphate available; indeed, phosphate was probably present at concentrations lower than the detection limit. This inference could be drawn because measurable in-situ bioremediation progress has occurred in groundwater at the French Limited site despite low phosphate concentrations.

Nevertheless, as a precaution, all injection wells at the French Limited site were dosed with 1 to 2 gallons of phosphate solution before shutdown. This was greatly in excess of quantities calculated necessary to maintain adequate phosphate. This would ensure the presence of excess phosphate and precluded phosphate being a limiting factor for intrinsic bioremediation progress.

1.2 Progress monitoring

In accordance with the *Site Closure Plan*, groundwater monitoring was performed during 1996. Interim results were presented in: *1995 Annual aquifer sampling report*[3], which included results of progress monitoring up to December 1995; *Natural attenuation progress report, 1st quarter, 1996*[4], which included results of progress monitoring up to January 1996; *Natural attenuation progress report, 2nd quarter, 1996*[5], which included results of progress monitoring up to April 1996, and provided an update

[2] Southwestern Environmental Consulting, Inc. January 1996.
[3] FLTG, Inc. March 1996.
[4] FLTG, Inc. April 1996.
[5] FLTG, Inc. June 1996.

of the natural attenuation modeling; and *Natural attenuation progress and site status report, 3rd Quarter, 1996*[6], which included results of progress monitoring up to July 1996. In the present report, results of progress monitoring, presented in Section 2.0, are further updated to October 1996.

1.3 Natural attenuation modeling update

In accordance with the *Site Closure Plan*, natural attenuation modeling was updated during 1996. Modeling updates were performed for the following reasons:

1. Calibration - additional data generated through progress monitoring were compared with model predictions and used to refine model assumptions

2. Model improvement - the base model used was itself updated by the model authors during the year

3. Revised prediction - additional data generated through progress monitoring were used to prepare revised prediction runs

Revised prediction runs used a "hybrid" approach for model initial conditions. This approach was developed in response to suggestions made during review of the *Natural attenuation progress report, 2nd quarter, 1996*. In the present report, results of updated natural attenuation modeling are presented in Section 3.0.

[6] FLTG, Inc. September 1996.

SECTION 2.0

2.0 Progress monitoring

Groundwater sampling was performed on October 7 and 8, 1996. An additional round of water levels were recorded on November 18, 1996. Locations of wells used for sampling and water level monitoring are shown in Figures 2-1 through 2-3. Data was generated in accordance with the approved *Site Closure Plan,* as summarized in Table 2-1.

Results were evaluated as follows:

1. Note concentrations above maximum contaminant level (< MCL) or not detected (ND)
2. Note concentrations > MCL, and trends, if any. Note if DL > MCL.
3. Note residual nitrate.
4. Prepare contour maps for DO, TOC, benzene, 1,2-DCA, & vinyl chloride.

2.1 Concentration < MCL or ND

Groundwater concentrations of the reported organics were reported < MCL or ND in the following wells:

FLTG-13, FLTG-14, INT-22, INT-60-P3, INT-108, INT-118, INT-135, INT-144, INT-214, S1-31, S1-33, S1-51-P3, S1-106A, S1-108A, S1-118, S1-121.

2.2 Concentration > MCL

For all samples, the detection limit for vinyl chloride (10 µg/L or higher) was greater than the MCL for vinyl chloride (2 µg/L). Therefore, areas exceeding the MCL for vinyl chloride could not be exactly depicted. In future sampling events, a 2 µg/L detection limit for vinyl chloride will be requested.

Groundwater samples from the wells with concentrations exceeding MCLs are presented in Table 2-2.

2.3 Residual nitrate

Nitrate was generally low (<2 mg/L-N) at most wells. Residual nitrate exceeded 2 mg/L-N but met the drinking water standard of 10 mg/L-N at one well:

Well	Nitrate in 1/96 (mg/L-N)	Nitrate in 4/96 (mg/L-N)	Nitrate in 7/96 (mg/L-N)	Nitrate in 10/96 (mg/L-N)	Trend from 7/96 to 10/96
S1-121	56.2	<0.2	0.8	6.0	up

Table 2-1

Progress monitoring, October 1996

Well	Water level	DO, pH, EC, T[1]	TOC, Nutrients[2]	Metals[3]	VOCs[4]
FLTG-13	✓	✓	✓	✗	✓
FLTG-14	✓	✓	✓	✗	✓
INT-22	✓	✓	✓	✗	✓
INT-26	✓	✓	✓	✗	✓
INT-59-P2	✓	✓	✗	✓	✗
INT-60-P2	✓	✓	✓	✗	✓
INT-101	✓	✓	✓	✓	✓
INT-106	✓	✓	✓	✗	✓
INT-108	✓	✓	✓	✗	✓
INT-118	✓	✓	✓	✓	✓
INT-120	✓	✓	✓	✗	✓
INT-123	✓	✓	✓	✗	✓
INT-127	✓	✓	✓	✗	✓
INT-130R	✓	✓	✓	✗	✓
INT-130RS	✓	✓	✓	✗	✓
INT-134	✓	✓	✓	✗	✓
INT-135	✓	✓	✓	✗	✓
INT-144	✓	✓	✓	✗	✓
INT-214	✓	✓	✓	✗	✓
INT-217	✓	✓	✓	✗	✓
INT-233	✓	✓	✓	✗	✓
P-5	✓	✗	✗	✗	✗
P-6	✓	✗	✗	✗	✗
S1-31	✓	✓	✓	✓	✓
S1-33	✓	✓	✓	✓	✓
S1-51-P3	✓	✓	✓	✗	✓
S1-64	✓	✗	✗	✗	✗
S1-106A	✓	✓	✓	✗	✓
S1-106R	✓	✓	✓	✗	✓
S1-108A	✓	✓	✓	✗	✓
S1-111	✓	✓	✗	✓	✗
S1-118	✓	✓	✓	✓	✓
S1-119	✓	✗	✗	✗	✗
S1-121	✓	✓	✓	✗	✓
S1-123	✓	✓	✓	✗	✓
S1-126	✓	✗	✗	✗	✗
S1-131	✓	✓	✓	✗	✓
S1-135	✓	✓	✓	✓	✓

Explanation
(1) DO = dissolved oxygen; EC = electrical conductivity; T = temperature
(2) TOC = total organic carbon; nutrients = ammonia-N, nitrate-N, orthophosphate-P, and potassium
(3) Metals = arsenic, chromium, and lead
(4) VOCs = 1,2- dichloroethane, acetone, benzene, toluene, and vinyl chloride

Table 2-2

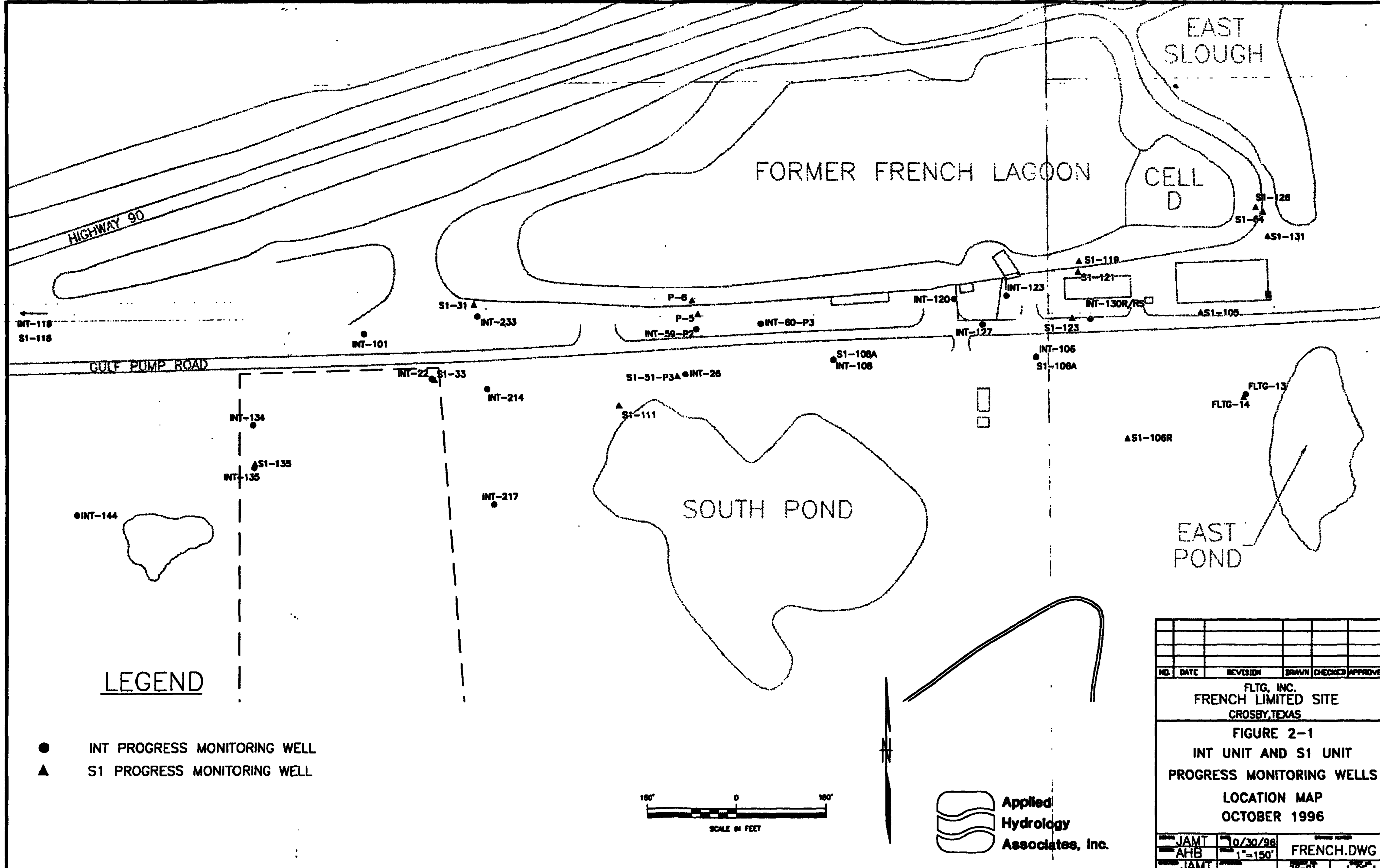
Concentrations > MCL

Well	Constituents and Concentrations (µg/L)	Trends from 7/96	Comments/ Recommended Action
INT-26	benzene 75	down	none
INT-101	benzene 33 arsenic 65	benzene down arsenic similar	arsenic just over MCL
INT-106	1,2-DCA 30 benzene 10	1,2-DCA down benzene up	none
INT-120	1,2-DCA 34	down	none
INT-123	1,2-DCA 300	up	none
INT-127	benzene 200	up	none
INT-130R	1,2-DCA 450 benzene <500	1,2-DCA same; benzene DL > MCL; other detection limits are high	request lower detection limits in future
INT-130RS	1,2-DCA 100 benzene <120 vinyl chloride 180	1,2-DCA down; vinyl chloride down; benzene DL > MCL; other detection limits are high	request lower detection limits in future
INT-134	1,2-DCA 110 benzene 56 vinyl chloride 190	all up	none
INT-217	benzene 22 vinyl chloride 17	both up	none
INT-233	benzene 500	up	none
S1-106R	benzene 25	down	none
S1-123	vinyl chloride 21	1,2-DCA and vinyl chloride markedly down[7]	none
S1-131	benzene 32	similar	none
S1-135	arsenic 69	up	none

Explanation

µg/L	micrograms per liter (ppb)
1,2-DCA	1,2-dichloroethane
DL	detection limit
MCL	maximum contaminant level (Federal drinking water standard)

7 This well was sampled in triplicate in October (the field sample, plus two QC duplicates). All results were consistent. QC duplicate analyses are included in Appendix A.



LEGEND

● INT PROGRESS MONITORING WELL

▲ S1 PROGRESS MONITORING WELL

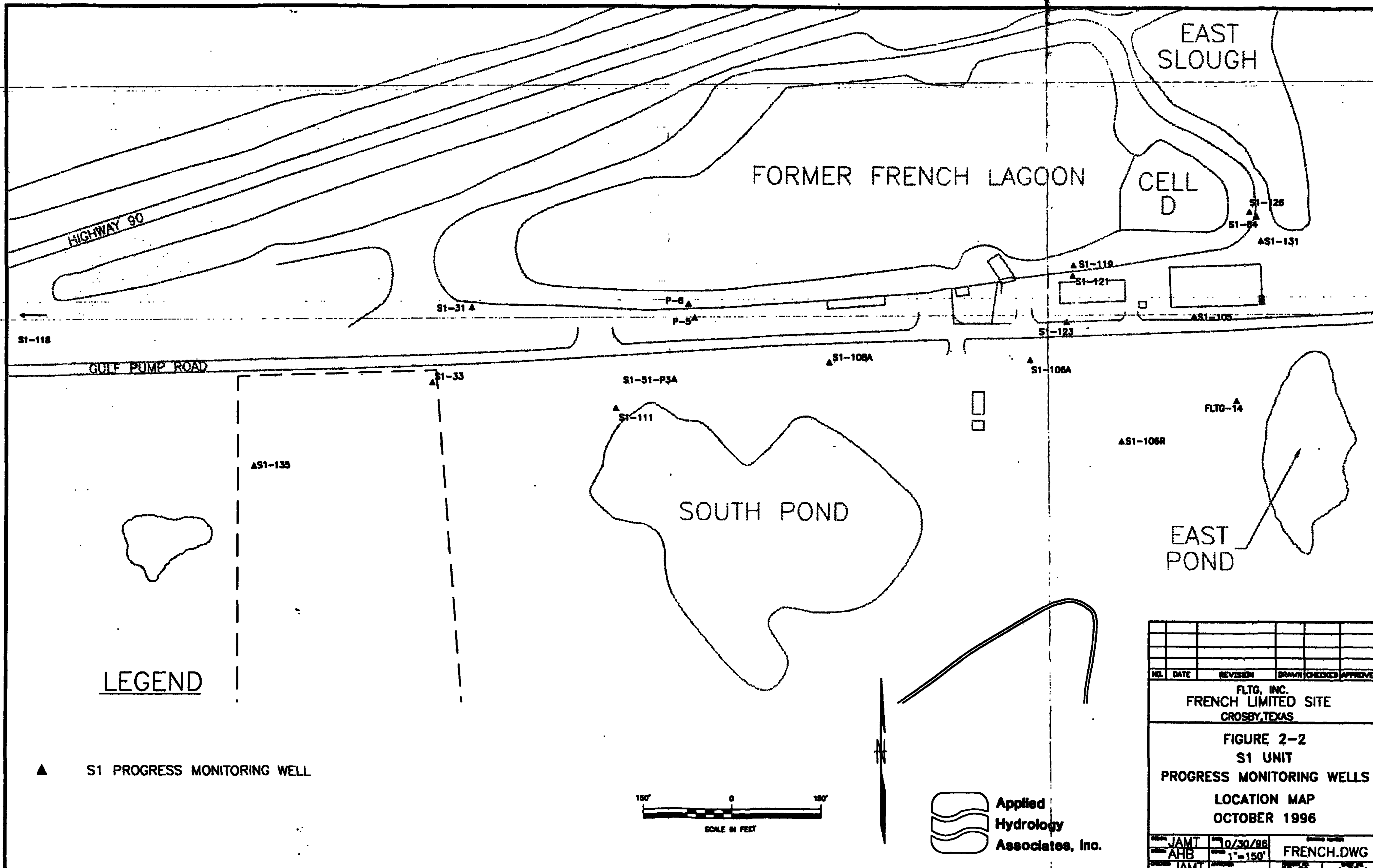
Applied Hydrology Associates, Inc.

NO.	DATE	REVISION	DRAWN	CHECKED	APPROVED

FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS

FIGURE 2-1
INT UNIT AND S1 UNIT
PROGRESS MONITORING WELLS
LOCATION MAP
OCTOBER 1996

JAMT	10/30/96	FRENCH.DWG	
AHB	1"=150'		
JAMT		28-01	1 OF 1



EAST SLOUGH
FORMER FRENCH LAGOON
CELL D
HIGHWAY 90
GULF PUMP ROAD
SOUTH POND
EAST POND
S1-126
S1-64
S1-131
S1-119
S1-121
S1-105
S1-123
S1-31
P-6
P-5
S1-118
S1-106A
S1-33
S1-51-P3A
S1-111
S1-135
FLTG-14
S1-106R
LEGEND
S1 PROGRESS MONITORING WELL
150'
0
150'
SCALE IN FEET
N
Applied Hydrology Associates, Inc.
NO.
DATE
REVISION
DRAWN
CHECKED
APPROVED
FLTG, INC.
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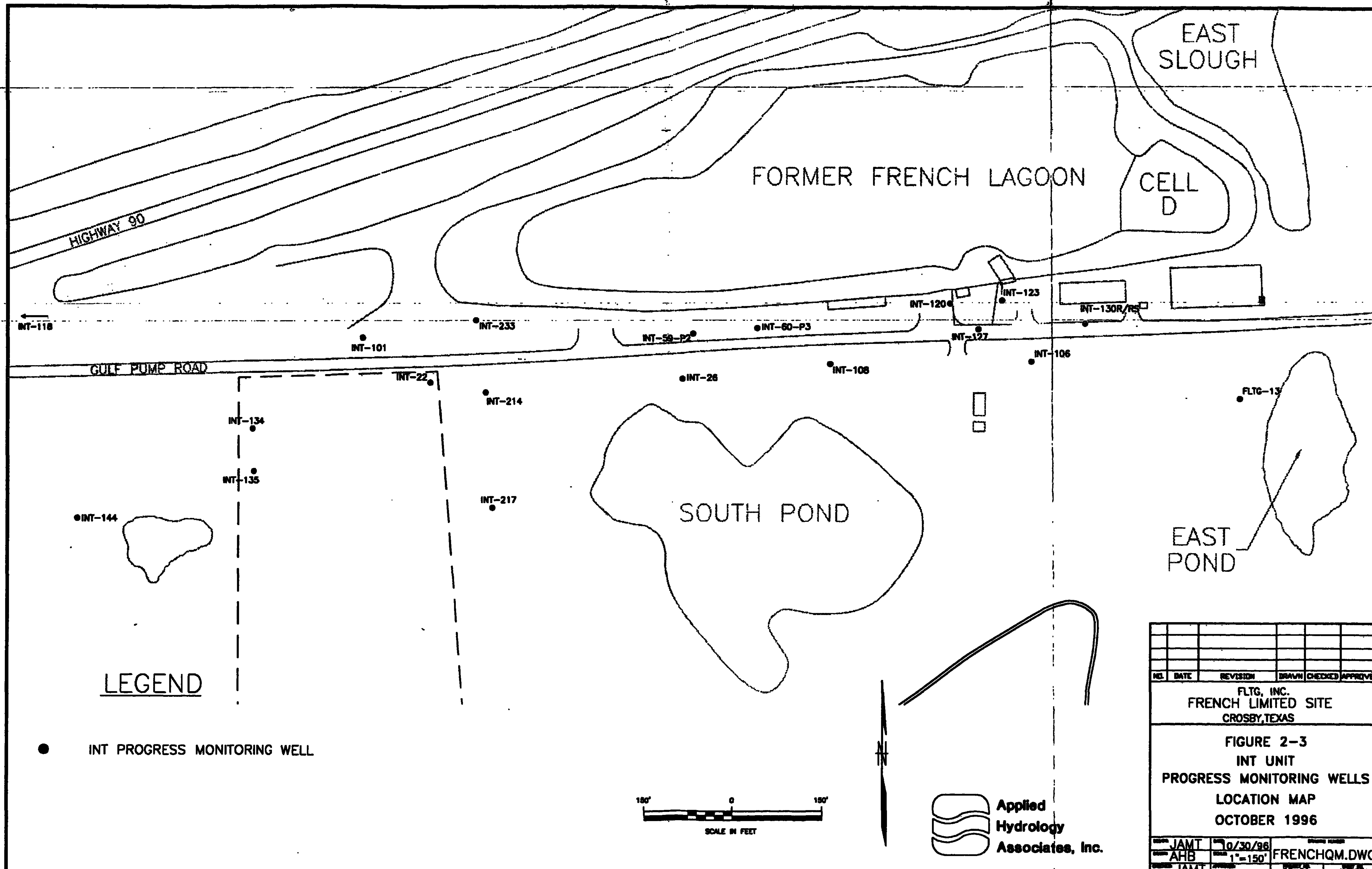
CROSBY, TEXAS
FIGURE 2-2
S1 UNIT
PROGRESS MONITORING WELLS
LOCATION MAP
OCTOBER 1996
JAMT
10/30/96
AHB
1"=150'
JAMT
FRENCH.DWG


EAST SLOUGH
FORMER FRENCH LAGOON
CELL D
HIGHWAY 90
INT-118
INT-233
INT-101
INT-59-P2
INT-60-P3
INT-120
INT-123
INT-127
INT-106
INT-108
INT-26
INT-22
INT-214
INT-134
INT-135
INT-217
INT-144
GULF PUMP ROAD
SOUTH POND
FLTG-13
EAST POND
LEGEND
INT PROGRESS MONITORING WELL
150' 0 150'
SCALE IN FEET
N
Applied Hydrology Associates, Inc.
NO. DATE REVISION DRAWN CHECKED APPROVED
FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-3
INT UNIT
PROGRESS MONITORING WELLS
LOCATION MAP
OCTOBER 1996
JAMT
10/30/96
AHB
1"=150'
FRENCHQM.DWG
JAMT
1 OF 1

Residual nitrate exceeded the drinking water standard of 10 mg/L-N at the wells summarized in Table 2-3.

Nitrate concentrations exceeding the MCL are expected to decline with continuing denitrifying reactions related to intrinsic bioremediation. There were no areas showing increases, indicating that migration/dispersion of high-nitrate groundwater into formerly low-nitrate areas apparently is complete.

2.4 Contour maps

Contour maps for water level, dissolved oxygen (DO), total organic carbon (TOC), benzene, 1,2-dichloroethane (1,2-DCA), vinyl chloride, and affected groundwater for the S1 and INT units in October 1996 are presented and discussed below.

2.4.1 Water levels

Tables 2-4 through 2-6 present revised top-of-casing well elevations, and water levels for October and November 1996. Figures 2-1 through 2-4 show interpreted groundwater levels in the S1 and INT units for October 1996 and November 1996. Required groundwater level monitoring is quarterly; additional measurements occasionally have been performed to attempt to develop average water levels over a year. Additional monthly water-level measurements are required before this can be completed.

Water-level contour maps for this area in the post-operational phase tend to reflect short-term, localized influences on water levels. These include short-term rainfall events, particularly as these affect the water level in the South Pond and other surface water bodies. Water levels were not recorded for the South Pond for October and November 1996; this will be added to future monitoring. The elevation of the South Pond is significant, as described below.

After storm events, water levels in surface water bodies rise, and they act as recharge areas for the S1 unit. In addition, the localized temporary loading elevates water levels in the underlying confined INT unit. Conversely, after prolonged periods without rainfall, evaporation form surface water bodies lowers pond levels, and they act as discharge areas for the S1 unit. Similarly, the reduced loading lowers water levels in the confined INT unit. The areal extent affected, and the time period for which rainfall events raise the South Pond water level, appears to depend on the amount of beaver activity, which increases the ponded area, and slows down the rate at which excess surface water can drain to the San Jacinto River.

Groundwater gradients measured in October and November 1996 were similar to those measured in July and August 1996, and were similar to those measured in late 1991 and early 1992, i.e., before active remediation started. In the S1 unit, hydraulic gradients appeared to be toward the South and East Ponds at 0.003 ft/ft. Between

Table 2-3

Residual nitrate > 10 mg/L-N

Well	Nitrate in 1/96 (mg/L-N)	Nitrate in 4/96 (mg/L-N)	Nitrate in 7/96 (mg/L-N)	Nitrate in 10/96 (mg/L-N)	Trend from 7/96 to 10/96
INT-60-P3	41.6	112.0	100.0	91.0	down
INT-118	0.2	371.0	0.4	<0.2	remained down: 4/96 value was anomalous
INT-120	63.1	23.3	66.0	21.1	down
INT-123	25.6	23.2	21.0	20.1	down
INT-127	4.0	47.9	<0.1	<0.2	remained down
INT-130R	new well	30.6	32.0	32.0	similar
INT-130RS	new well	23.2	20.0	17.5	down
S1-033	131.0	288.0	0.8	<0.2	remained down
S1-106A	92.3	16.6	23.3	11.4	down
S1-131	8.6	306.0	<0.1	0.4	remained down: 4/96 value was anomalous

Explanation

mg/L-N milligrams per liter as nitrogen
< less than

Table 2-4

	Date of survey			
Well	pre-6/12/96	6/12/96	9/10/96	Current
FLTG-13	12.05	not found	11.81	11.81
FLTG-14	11.55	not found	11.48	11.48
INT-22	12.44	14.27		14.27
INT-26	11.93	12.33		12.33
INT-59-P2	11.68	14.93		14.93
INT-60-P3	12.02	14.68		14.68
INT-101	13.15	13.12		13.12
INT-106	11.77	11.62		11.62
INT-108	13.54	13.55		13.55
INT-118	19.53	could not open	17.00	17.00
INT-120	15.13	17.61		17.61
INT-123	15.1	18.04		18.04
INT-127	11.18	11.18		11.18
INT-130R	new	11.24		11.24
INT-130RS	new	11.63		11.63
INT-134	16.79	14.81		14.81
INT-135	17.99	17.93		17.93
INT-144	new	18.83		18.83
INT-214	new	11.93		11.93
INT-217	new	11.13		11.13
INT-233	new	15.38		15.38
P-5	15.11	17.85		17.85
P-6	15.59	18.45		18.45
S1-31	13.12	16.46		16.46
S1-33	11.56	12.78		12.78
S1-51-P3	12.2	12.22		12.22
S1-64	uncertain	14.67	14.61	14.61
S1-105	12.25	11.91		11.91
S1-106A	new	11.18	11.22	11.22
S1-106R	new	new	15.53	15.53
S1-108A	new	14.26		14.26
S1-111	12.39	not found	12.30	12.30
S1-118	18.99	unable to open	18.92	18.92
S1-119	15.33	18.49		18.49
S1-121	15.04	17.85		17.85
S1-123	10.7	10.77		10.77
S1-126	15.18	14.75		14.75
S1-131	12.4	7.7	12.38	12.38
S1-135	18.02	18.02		18.02

Table 2-5

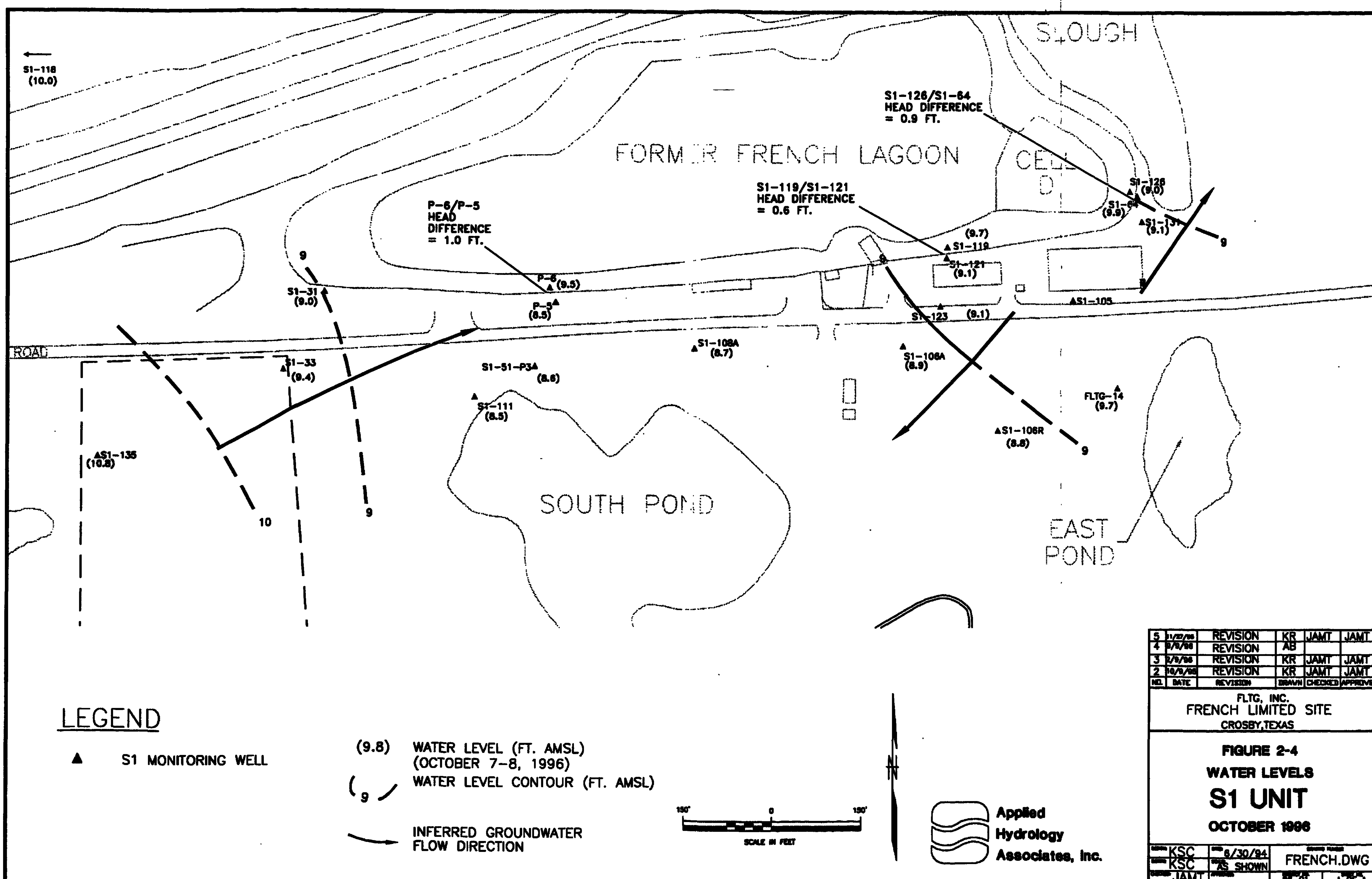
Groundwater levels, October 7, 1996
(ft-MSL)

	Measured	TOC from latest survey	
Well	DTW (ft)	TOC (ft-MSL)	WL (ft-MSL)
FLTG-13	2.37	11.81	9.44
FLTG-14	1.74	11.48	9.74
INT-22	5.29	14.27	8.98
INT-26	3.68	12.33	8.65
INT-59-P2	6.78	14.93	8.15
INT-60-P3	6.06	14.68	8.62
INT-101	5.48	13.12	7.64
INT-106	2.82	11.62	8.80
INT-108	4.91	13.55	8.64
INT-118	10.00	17.00	7.00
INT-120	8.84	17.61	8.77
INT-123	9.19	18.04	8.85
INT-127	2.39	11.18	8.79
INT-130R	2.45	11.24	8.79
INT-130RS	2.85	11.63	8.78
INT-134	9.68	14.81	5.13
INT-135	12.06	17.93	5.87
INT-144	15.62	18.83	3.21
INT-214	3.03	11.93	8.90
INT-217	3.48	11.13	7.65
INT-233	6.48	15.38	8.90
P-5	9.34	17.85	8.51
P-6	9.00	18.45	9.45
S1-31	7.46	16.46	9.00
S1-33	3.43	12.78	9.35
S1-51-P3	3.67	12.22	8.55
S1-64	5.61	14.61	9.00
S1-105	NM	11.91	NM
S1-106A	2.28	11.22	8.94
S1-106R	6.71	15.53	8.82
S1-108A	5.61	14.26	8.65
S1-111	3.79	12.30	8.51
S1-118	8.95	18.92	9.97
S1-119	8.81	18.49	9.68
S1-121	8.79	17.85	9.06
S1-123	1.67	10.77	9.10
S1-126	4.85	14.75	9.90
S1-131	3.24	12.38	9.14
S1-135	7.18	18.02	10.84

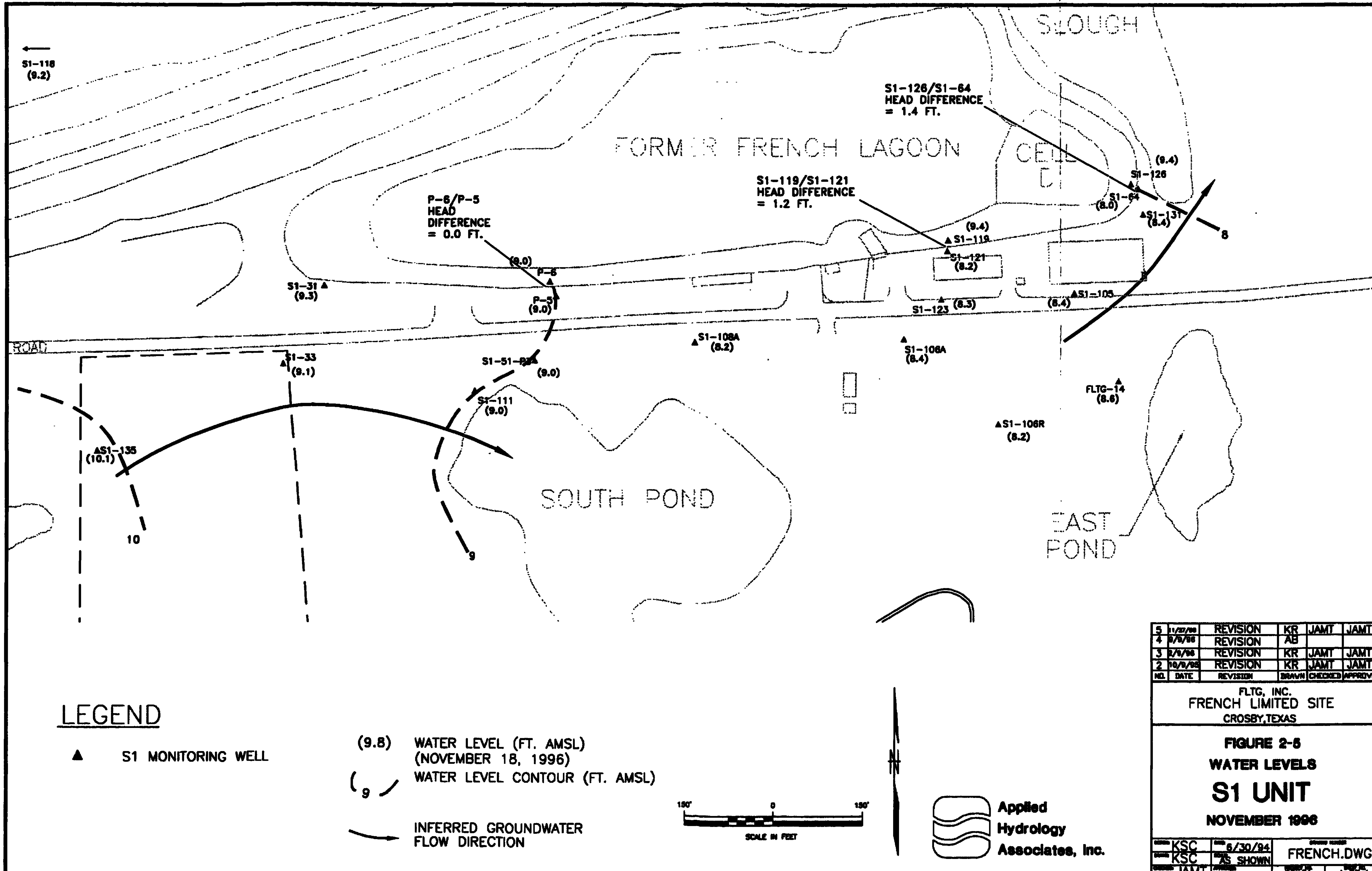
Table 2-6

Groundwater levels, November 18, 1996
(ft-MSL)

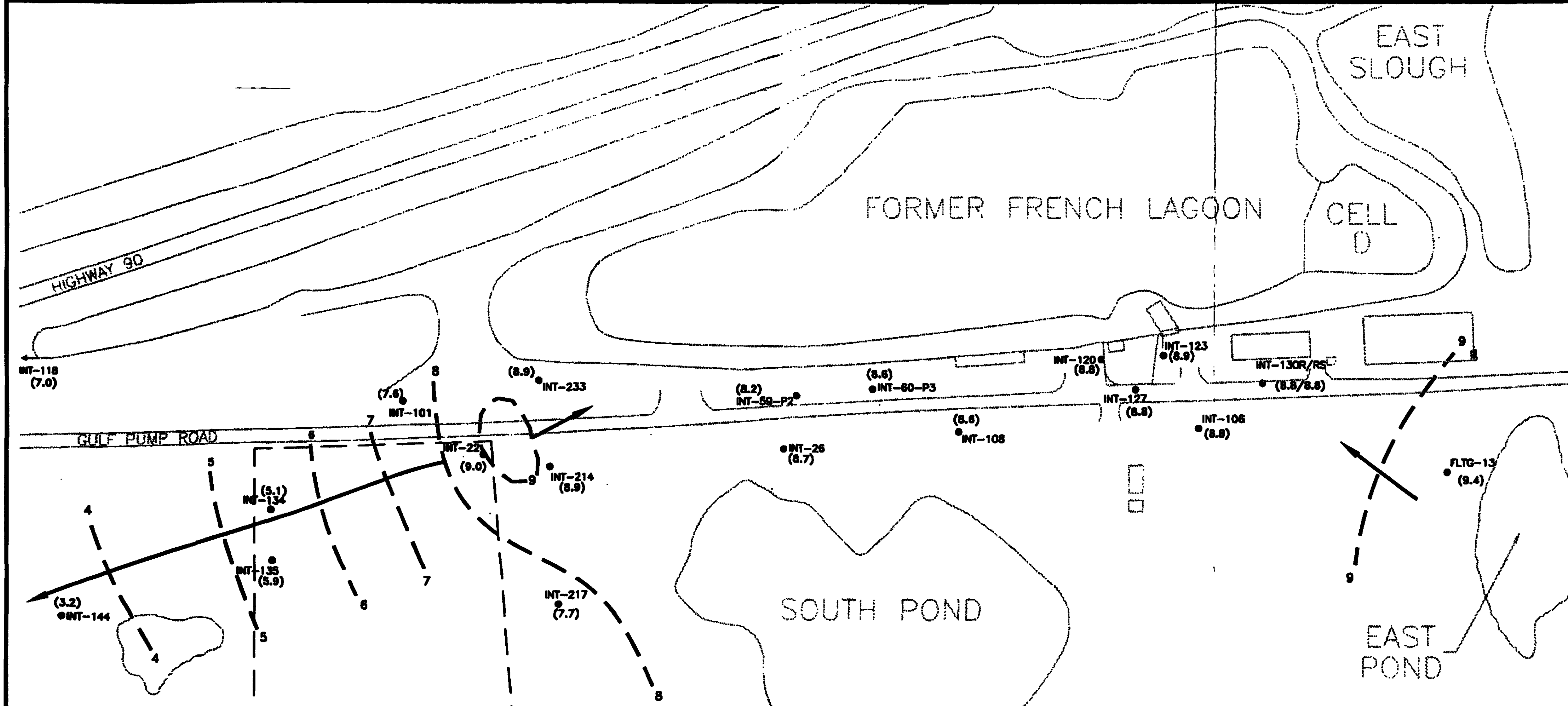
	Measured	TOC from latest survey	
Well	*DTW (ft)*	*TOC (ft-MSL)*	*WL (ft-MSL)*
FLTG-13	3.48	11.81	8.33
FLTG-14	2.93	11.48	8.55
INT-22	5.48	14.27	8.79
INT-26	3.28	12.33	9.05
INT-59-P2	6.28	14.93	8.65
INT-60-P3	6.20	14.68	8.48
INT-101	6.05	13.12	7.07
INT-106	3.31	11.62	8.31
INT-108	4.73	13.55	8.82
INT-118	10.67	17.00	6.33
INT-120	8.95	17.61	8.66
INT-123	9.60	18.04	8.44
INT-127	2.66	11.18	8.52
INT-130R	3.01	11.24	8.23
INT-130RS	3.41	11.63	8.22
INT-134	8.92	14.81	5.89
INT-135	15.35	17.93	2.58
INT-144	15.67	18.83	3.16
INT-214	3.07	11.93	8.86
INT-217	3.37	11.13	7.76
INT-233	6.44	15.38	8.94
P-5	8.88	17.85	8.97
P-6	9.43	18.45	9.02
S1-31	7.18	16.46	9.28
S1-33	3.71	12.78	9.07
S1-51-P3	3.23	12.22	8.99
S1-64	6.65	14.61	7.96
S1-105	3.48	11.91	8.43
S1-106A	2.81	11.22	8.41
S1-106R	7.31	15.53	8.22
S1-108A	6.04	14.26	8.22
S1-111	3.32	12.30	8.98
S1-118	9.68	18.92	9.24
S1-119	9.12	18.49	9.37
S1-121	9.69	17.85	8.16
S1-123	2.44	10.77	8.33
S1-126	5.31	14.75	9.44
S1-131	4.03	12.38	8.35
S1-135	7.93	18.02	10.09



SLOUGH
S1-118
(10.0)
FORMER FRENCH LAGOON
CELL D
S1-126/S1-64
HEAD DIFFERENCE
= 0.9 FT.
S1-126
(9.0)
S1-64
(9.9)
S1-131
(9.1)
S1-119/S1-121
HEAD DIFFERENCE
= 0.6 FT.
(9.7)
S1-119
S1-121
(9.1)
P-6/P-5
HEAD
DIFFERENCE
= 1.0 FT.
P-6 (9.5)
P-5
(8.5)
S1-31
(9.0)
S1-105
S1-123
(9.1)
ROAD
S1-33
(9.4)
S1-108A
(8.7)
S1-106A
(8.9)
S1-51-P3
(8.6)
S1-111
(8.5)
FLTG-14
(9.7)
S1-106R
(8.8)
S1-135
(10.8)
10
9
SOUTH POND
EAST POND
LEGEND
S1 MONITORING WELL
(9.8) WATER LEVEL (FT. AMSL) (OCTOBER 7-8, 1996)
9 WATER LEVEL CONTOUR (FT. AMSL)
INFERRED GROUNDWATER FLOW DIRECTION
150' 0 150'
SCALE IN FEET
N
Applied Hydrology Associates, Inc.
5 | 11/22/96 | REVISION | KR | JAMT | JAMT
4 | 8/8/96 | REVISION | AB
3 | 2/5/96 | REVISION | KR | JAMT | JAMT
2 | 10/9/95 | REVISION | KR | JAMT | JAMT
NO. | DATE | REVISION | DRAWN | CHECKED | APPROVED
FLTG, INC.
FRENCH LIMITED SITE
CROSBY,TEXAS
FIGURE 2-4
WATER LEVELS
S1 UNIT
OCTOBER 1996
KSC
KSC
JAMT
6/30/94
AS SHOWN
FRENCH.DWG
1 OF 1

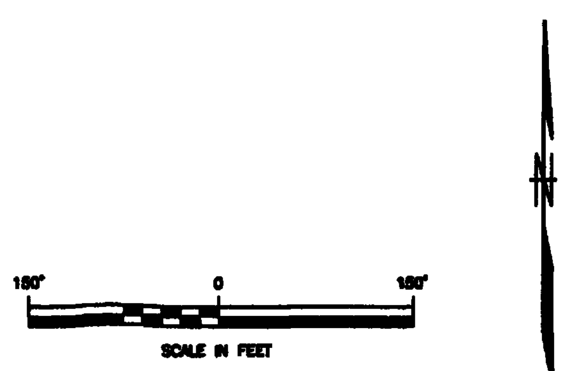


S1-118
(9.2)
SLOUGH
FORMER FRENCH LAGOON
CELL D
S1-126/S1-64
HEAD DIFFERENCE
= 1.4 FT.
S1-119/S1-121
HEAD DIFFERENCE
= 1.2 FT.
P-6/P-5
HEAD
DIFFERENCE
= 0.0 FT.
(9.4)
S1-126
S1-64
(8.0)
S1-131
(8.4)
(9.4)
S1-119
S1-121
(8.2)
8
(9.0)
P-6
P-5
(9.0)
S1-31
(9.3)
S1-123
(8.3)
S1-105
(8.4)
ROAD
S1-108A
(8.2)
S1-106A
(8.4)
S1-33
(9.1)
S1-51-R
(9.0)
S1-111
(9.0)
FLTG-14
(8.6)
S1-106R
(8.2)
S1-135
(10.1)
SOUTH POND
EAST POND
10
9
LEGEND
S1 MONITORING WELL
(9.8) WATER LEVEL (FT. AMSL)
(NOVEMBER 18, 1996)
9 WATER LEVEL CONTOUR (FT. AMSL)
INFERRED GROUNDWATER FLOW DIRECTION
150' 0 150'
SCALE IN FEET
N
Applied
Hydrology
Associates, Inc.
5 REVISION KR JAMT JAMT
4 REVISION AB
3 REVISION KR JAMT JAMT
2 REVISION KR JAMT JAMT
NO. DATE REVISION DRAWN CHECKED APPROVED
FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-5
WATER LEVELS
S1 UNIT
NOVEMBER 1996
KSC 6/30/94
KSC AS SHOWN
JAMT
FRENCH.DWG



LEGEND

●	INT MONITORING WELL
(8.62)	WATER LEVEL (FT. AMSL) (OCTOBER 7 – 8, 1996)
8	WATER LEVEL CONTOUR (FT. AMSL)
	INFERRED GROUNDWATER FLOW DIRECTION



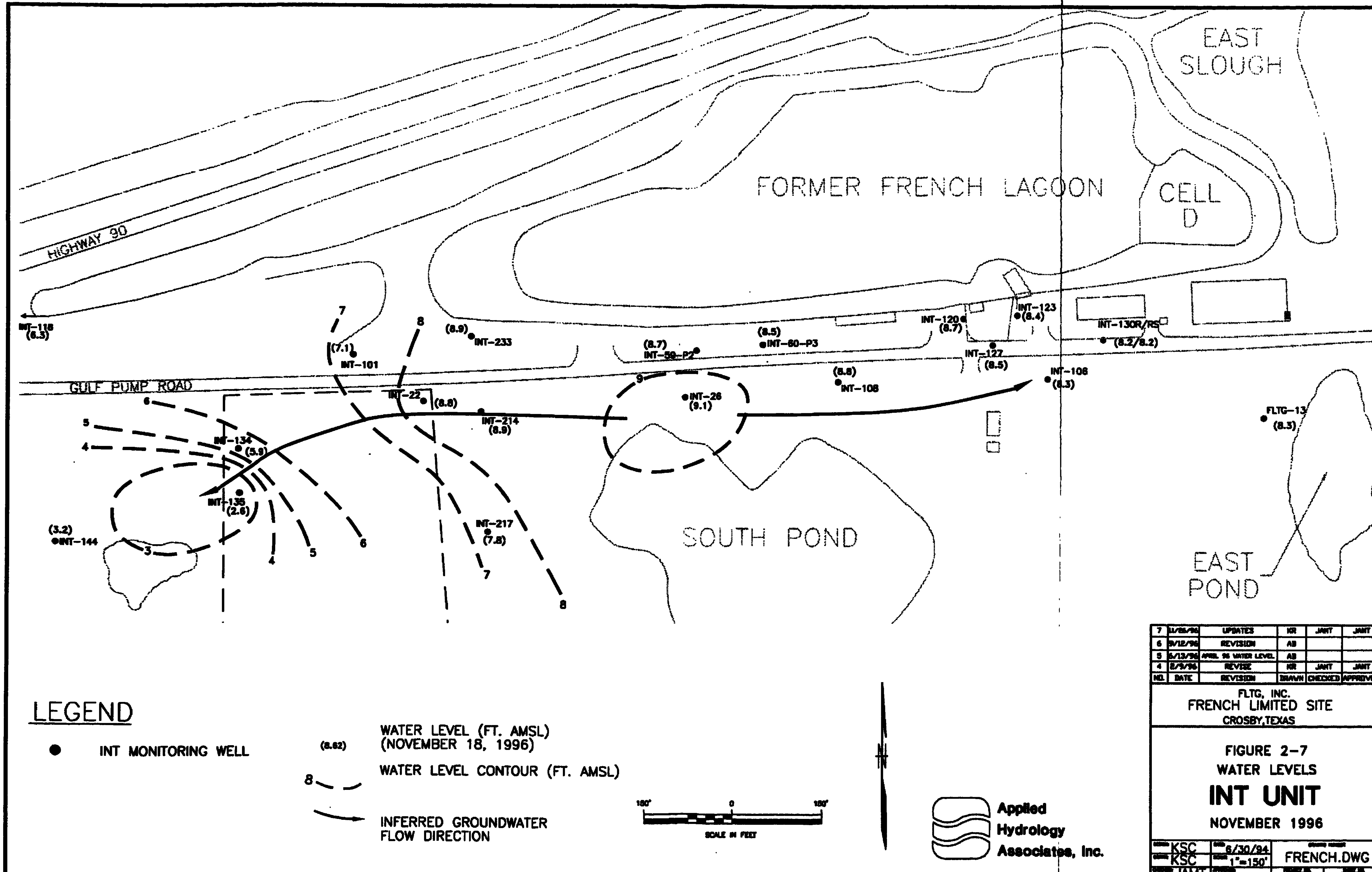
Applied Hydrology Associates, Inc.

NO.	DATE	REVISION	DRAWN	CHECKED	APPROVED
7	11/26/96	UPDATES	KR	JAMT	JAMT
6	9/12/96	REVISION	AB		
5	6/13/96	APRIL 96 WATER LEVEL	AB		
4	2/9/96	REVISE	KR	JAMT	JAMT

FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS

FIGURE 2-6
WATER LEVELS
INT UNIT
OCTOBER 1996

KSC	6/30/94	FRENCH.DWG
KSC	1"=150'	
JAMT		26-01 / 1 OF 1



EAST SLOUGH
FORMER FRENCH LAGOON
CELL D
HIGHWAY 90
GULF PUMP ROAD
SOUTH POND
EAST POND
INT-118 (8.3)
INT-101 (7.1)
(8.9) INT-233
(8.7) INT-59-P2
(8.5) INT-60-P3
INT-120 (8.7)
INT-123 (8.4)
INT-130R/RS (8.2/8.2)
INT-127 (8.5)
(8.8) INT-108
INT-106 (8.3)
INT-22 (8.8)
INT-214 (8.9)
INT-26 (9.1)
INT-134 (5.9)
INT-135 (2.6)
(3.2) INT-144
INT-217 (7.8)
FLTG-13 (8.3)
3
4
5
6
7
8
9
LEGEND
INT MONITORING WELL
(8.62) WATER LEVEL (FT. AMSL) (NOVEMBER 18, 1996)
8 WATER LEVEL CONTOUR (FT. AMSL)
INFERRED GROUNDWATER FLOW DIRECTION
150' 0 150'
SCALE IN FEET
N
Applied Hydrology Associates, Inc.
7 11/26/96 UPDATES KR JAMT JAMT
6 9/12/96 REVISION AB
5 6/13/96 APRIL 96 WATER LEVEL AB
4 2/9/96 REVISE KR JAMT JAMT
NO. DATE REVISION DRAWN CHECKED APPROVED
FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-7
WATER LEVELS
INT UNIT
NOVEMBER 1996
KSC 6/30/94
KSC 1"=150'
JAMT
FRENCH.DWG
1 OF 1

pond areas, gradients were low to flat. In the INT unit, the hydraulic gradient over most of the area south of the cutoff wall was low to flat. A steeper hydraulic gradient prevailed over the southwest area of the site. In this area, gradients were between 0.009 and 0.018 ft/ft to the west-southwest. These observations are generally consistent with predictions made in regional flow modeling presented in the 1995 *Natural Attenuation Modeling Report*, which anticipated zones of near-stagnation on the north and south sides of the cutoff wall, and an overall regional gradient to the southwest in the southwest part of the site.

Previous modeling did not incorporate the effects of varying recharge on pond levels, which was assumed to have no net effect in the long term. For this reason, it is planned to develop long-term average water table maps in future progress monitoring reports.

Three sets of paired S1 unit monitoring wells track head differences across the cutoff wall. The well pairs are P-6/P-5; S1-119/S1-121; and S1-126/S1-64. The first well of each pair is inside the cutoff wall; the second well is outside. Recorded elevations are presented in Table 2-7. The hydraulic gradient was inward at S1-119/S1-121 and S1-126/S1-64, and outward at P-6/P-5. Generally, outward hydraulic gradients with up to 2 feet head difference have prevailed since July 1996. In general, water level elevations inside the cutoff wall have varied significantly less than those outside the cutoff wall, probably because water levels inside the wall are isolated from the effects of surface water level changes outside the wall.

The effectiveness of the steel sheetpile cutoff wall system used at the French Limited site was confirmed by long-term testing described in *INT-11 DNAPL area, cutoff wall installation and permeability certification report*[8]. This report concluded that the cutoff wall is equivalent to a conventional 2.5 foot thick slurry wall with a permeability of 1×10^{-9} cm/sec. Hence, an outward hydraulic gradient is not likely to result in significant outward migration of groundwater. However, an inward hydraulic gradient is preferable, as it provides additional migration control. It is expected that, as the phreatophytes inside the wall develop deeper and more effective root systems, there will be an overall change to an inward hydraulic gradient.

2.4.2 Dissolved oxygen

Dissolved oxygen contour maps for October 1996 are presented in Figures 2-8 and 2-9. In the S1 unit, only one area (at well S1-111) has elevated DO concentrations (>2 mg/L). An elevated DO area which was present at S1-106A/S1-123 in July 1996 is absent. In the INT unit, three areas (at wells INT-144, INT-60-P3, and INT-123) have elevated concentrations, similar to July 1996. Of these areas, only that at INT-60-P3 is significantly above 2 mg/L. Each of the elevated DO areas is in an area of historically low TOC concentrations. These results indicate that most of the residual DO that was in the aquifer at the end of active remediation has been removed, presumably through continued aerobic bioremediation.

[8] Applied Hydrology Associates, Inc. August 1995.

Table 2-7

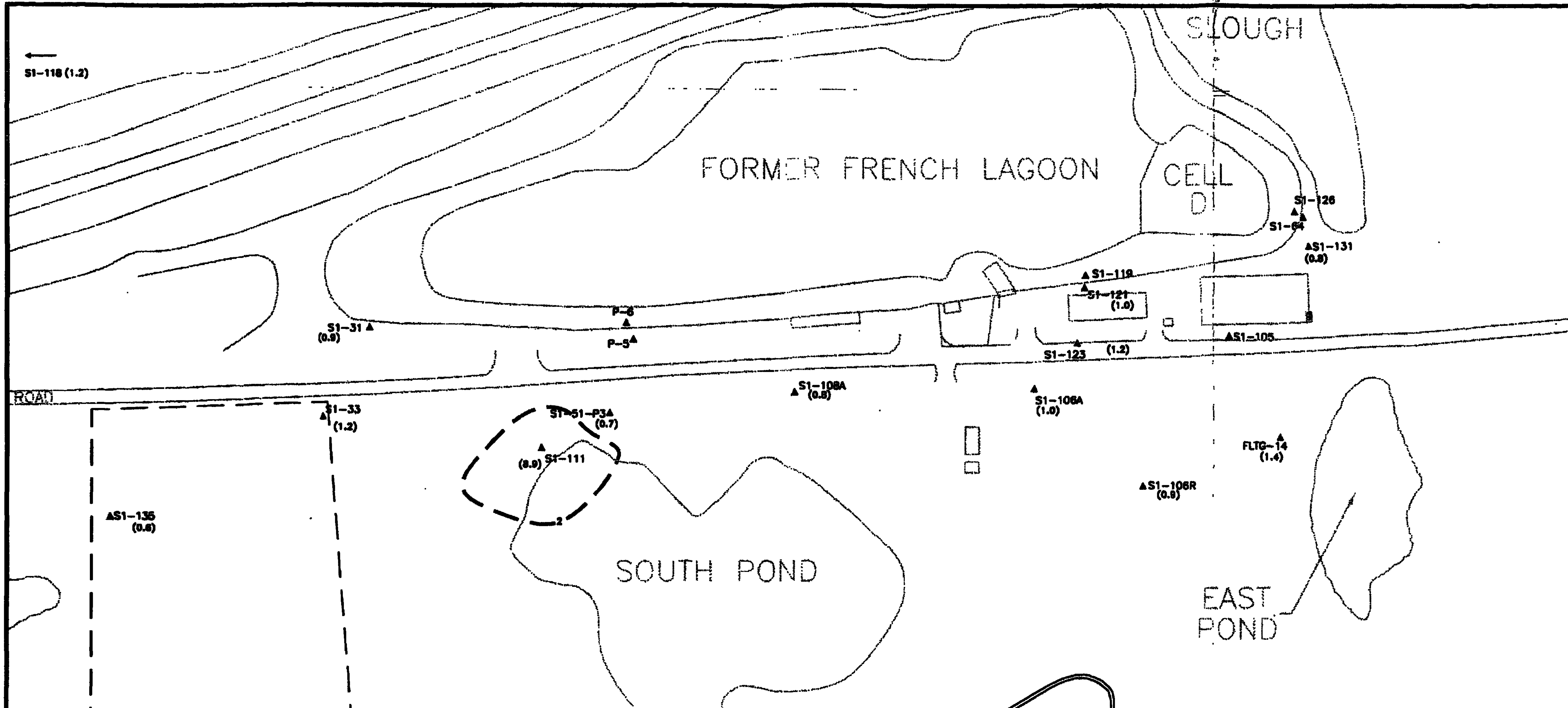
Cutoff wall head differences

Values are in ft-MSL; dates are for 1996

	April 8-12	July 10-16	August 8	October 7-8	November 18
P-6	9.60	9.07	9.20	9.00	9.43
P-5	6.40	9.68	10.11	9.34	8.88
Δh	3.20	-0.61	-0.91	-0.34	0.55
S1-119	8.10	8.60	8.98	8.81	9.12
S1-121	6.52	9.70	10.97	8.79	9.69
Δh	1.58	-1.10	-1.99	0.02	-0.57
S1-126	8.68	4.67	5.18	4.85	5.31
S1-64	5.92	6.47	6.65	5.61	6.65
Δh	2.76	-1.80	-1.47	-0.76	-1.34

Explanation

Δh head difference (ft): negative values indicate an ~~outward~~ hydraulic gradient



LEGEND

▲ S1 MONITORING WELL

(0.1) DISSOLVED OXYGEN (ppm)

2 DISSOLVED OXYGEN CONTOUR (ppm)

150' 0 150'

SCALE IN FEET

N

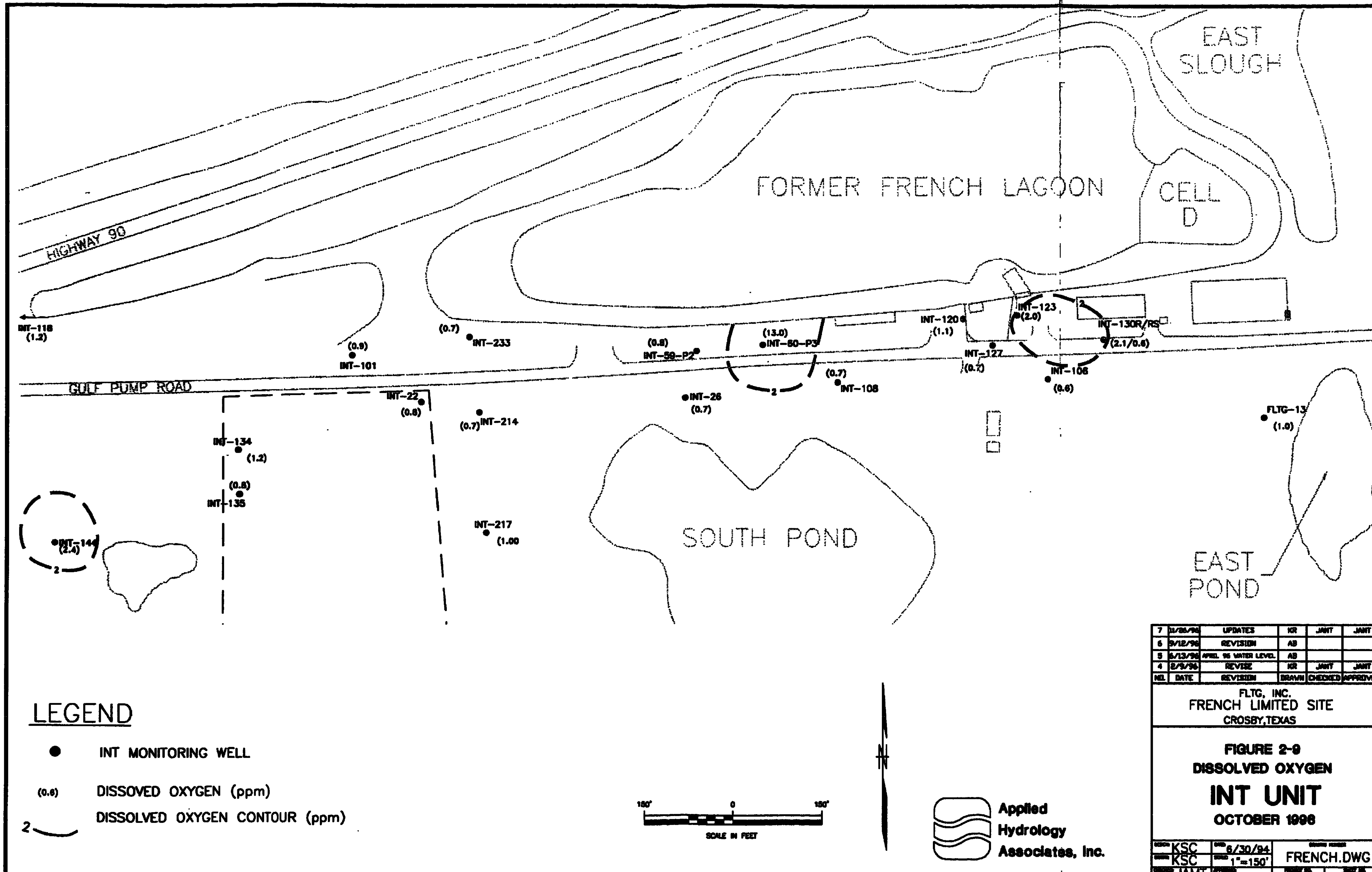
Applied Hydrology Associates, Inc.

NO.	DATE	REVISION	DRAWN	CHECKED	APPROVED
5	11/27/96	REVISION	KR	JAMT	JAMT
4	9/9/96	REVISION	AB		
3	2/9/96	REVISION	KR	JAMT	JAMT
2	10/9/95	REVISION	KR	JAMT	JAMT

FLTG, INC.
FRENCH LIMITED SITE
CROSBY,TEXAS

FIGURE 2-8
DISSOLVED OXYGEN
S1 UNIT
OCTOBER 1996

KSC	6/30/94	FRENCH.DWG	
KSC	AS SHOWN		
JAMT		28-01	1 OF 1


EAST SLOUGH
FORMER FRENCH LAGOON
CELL D
HIGHWAY 90
GULF PUMP ROAD
SOUTH POND
EAST POND
INT-118 (1.2)
(0.9) INT-101
(0.7) INT-233
(0.8) INT-59-P2
(13.0) INT-60-P3
2
INT-120 (1.1)
INT-123 (2.0)
INT-130R/RS (2.1/0.6)
INT-127 (0.7)
INT-106 (0.6)
(0.7) INT-108
INT-26 (0.7)
INT-22 (0.8)
(0.7) INT-214
INT-134 (1.2)
(0.8) INT-135
INT-144 (2.4)
INT-217 (1.00
FLTG-13 (1.0)
LEGEND
INT MONITORING WELL
(0.6) DISSOVED OXYGEN (ppm)
2 DISSOLVED OXYGEN CONTOUR (ppm)
150' 0 150'
SCALE IN FEET
N
Applied Hydrology Associates, Inc.
7 11/26/96 UPDATES KR JAMT JAMT
6 5/12/96 REVISION AB
5 6/13/96 APRIL 96 WATER LEVEL AB
4 2/9/96 REVISE KR JAMT JAMT
NO. DATE REVISION DRAWN CHECKED APPROVED
FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-9
DISSOLVED OXYGEN
INT UNIT
OCTOBER 1996
KSC 6/30/94
KSC 1"=150'
JAMT
FRENCH.DWG
1 OF 1

2.4.3 Total organic carbon

Total organic carbon contour maps for October 1996 are presented in Figures 2-10 and 2-11. TOC concentrations are generally higher for October 1996 than for July 1996; the area of elevated TOC extends over a similar, but larger area in both units. The maximum TOC concentration in the S1 unit is 42.7 mg/L at S1-131. High TOC concentrations (>5 mg/L) are located in two areas:

1. southwest - at S1-135, S1-31, and S1-50-P3
2. east - at S1-123, S1-106R, and S1-131

TOC was not determined for S1-111, but it is expected to be low because of the elevated DO concentration.

The maximum TOC concentration in the INT unit is 98.9 mg/L at INT-233. High TOC concentrations are located in four areas:

1. southwest - from INT-134/135 to INT-233
2. south - at INT-217
3. central - at INT-26
4. east - at INT-127, INT-106, and INT-130R/RS

TOC was not determined for INT-60-P3, but it is expected to be low because of the elevated DO concentration.

Areas of high TOC correspond to areas of low DO. Where these areas also contain elevated target chemicals, particularly benzene, continued natural attenuation is likely to be slow. Addition of dissolved oxygen through a passive approach (e.g., calcium peroxide) may accelerate natural attenuation in such areas. This issue is discussed further in Section 4.0.

2.4.4 Benzene

Benzene contour maps for October 1996 are presented in Figures 2-12 and 2-13. The areas of elevated benzene concentration are the same as in July 1996.

The maximum benzene concentration in the S1 unit is 32 μg/L at S1-131. Benzene was detected above the MCL (5 μg/L) at two wells:

1. S1-131
2. S1-106R

Both wells are in the east area of high TOC and low DO.

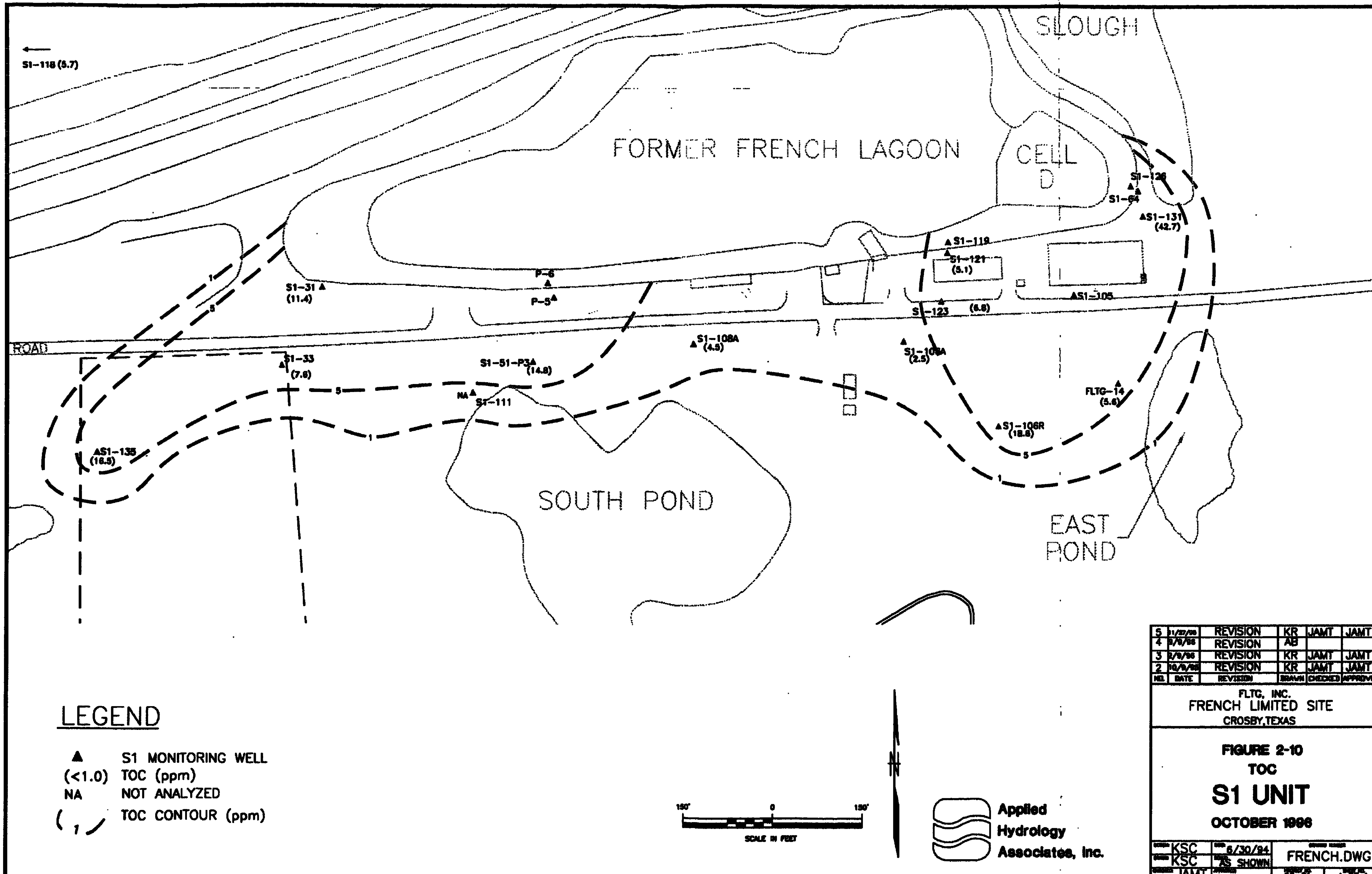
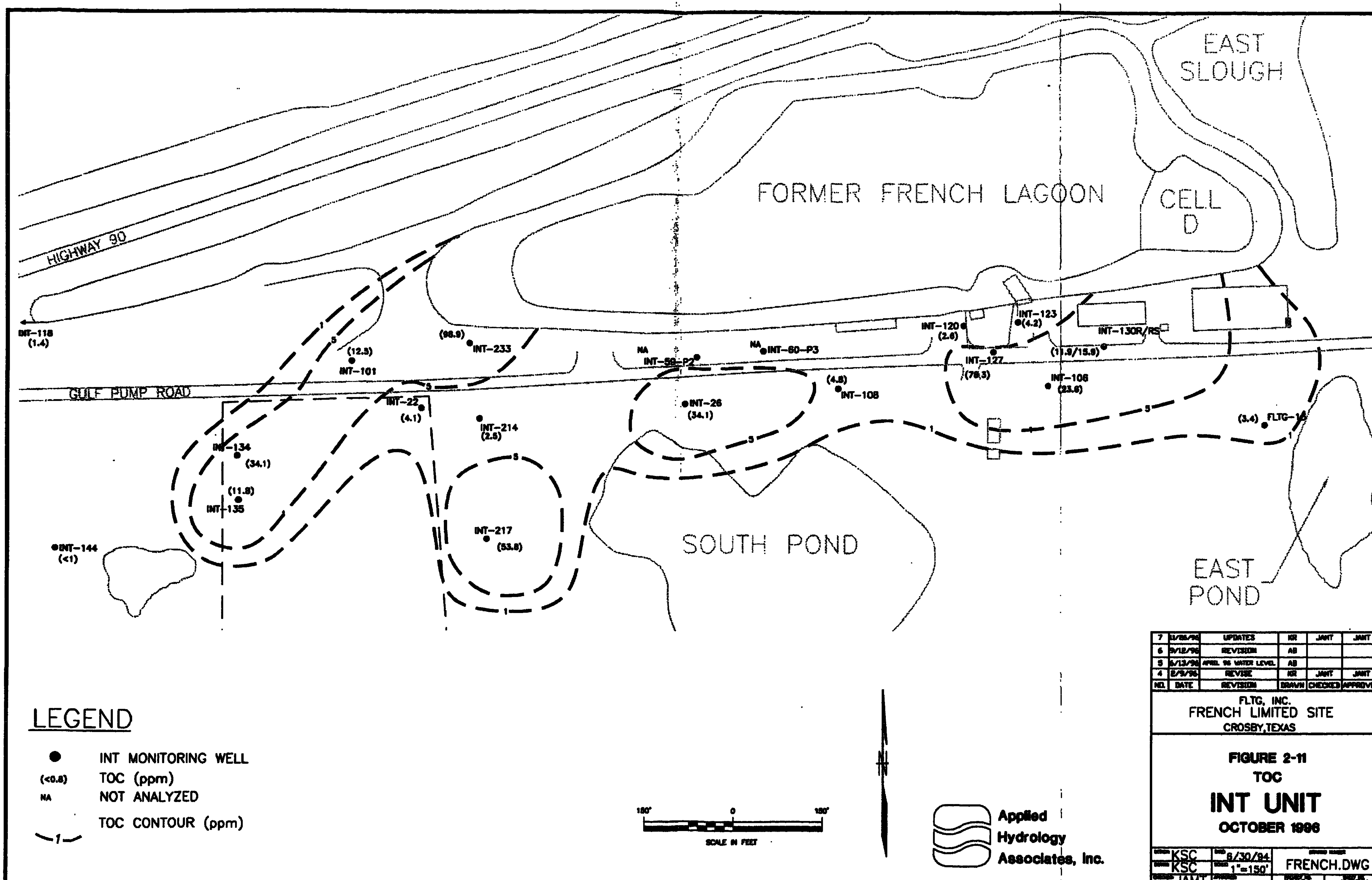
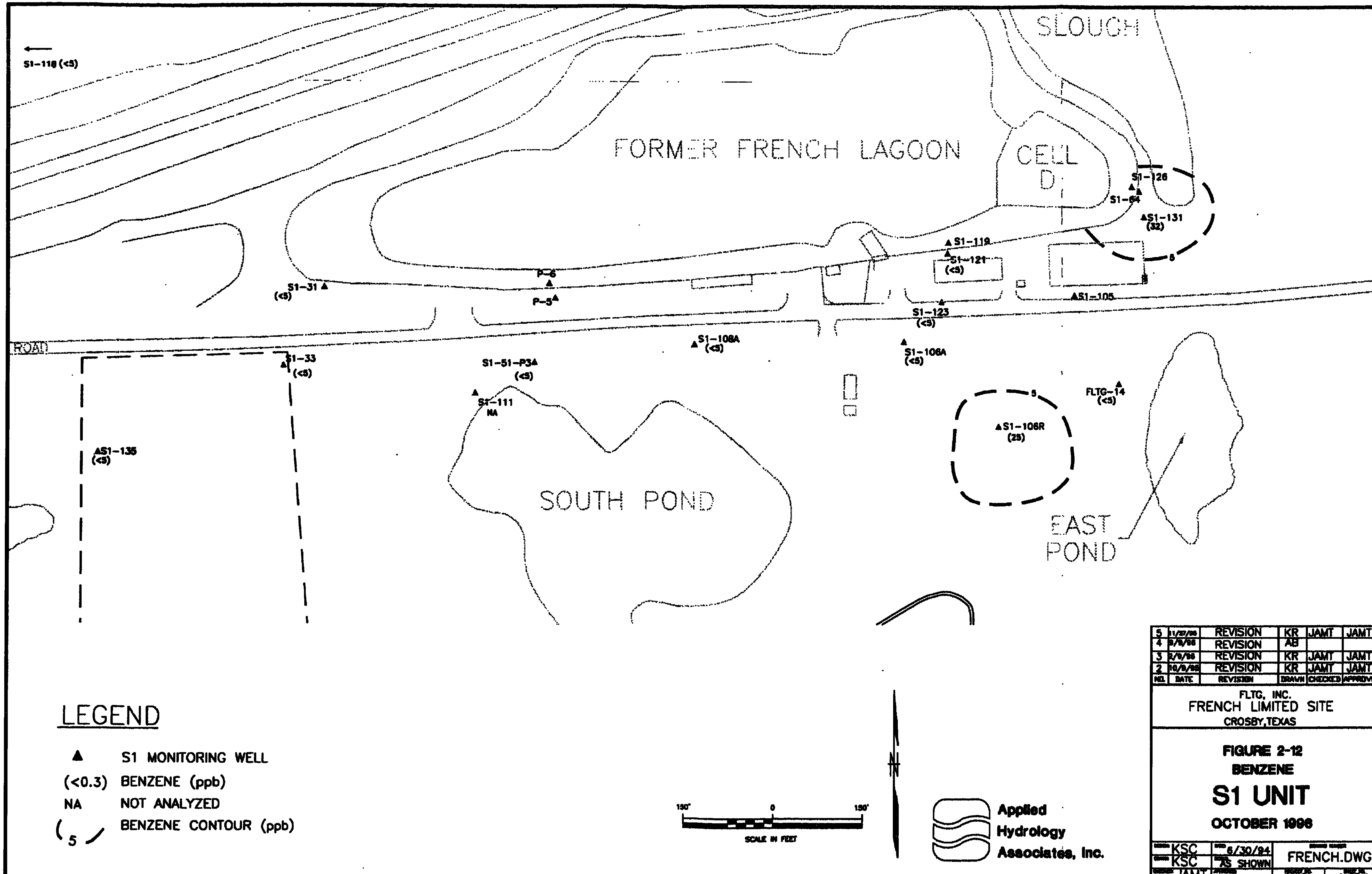
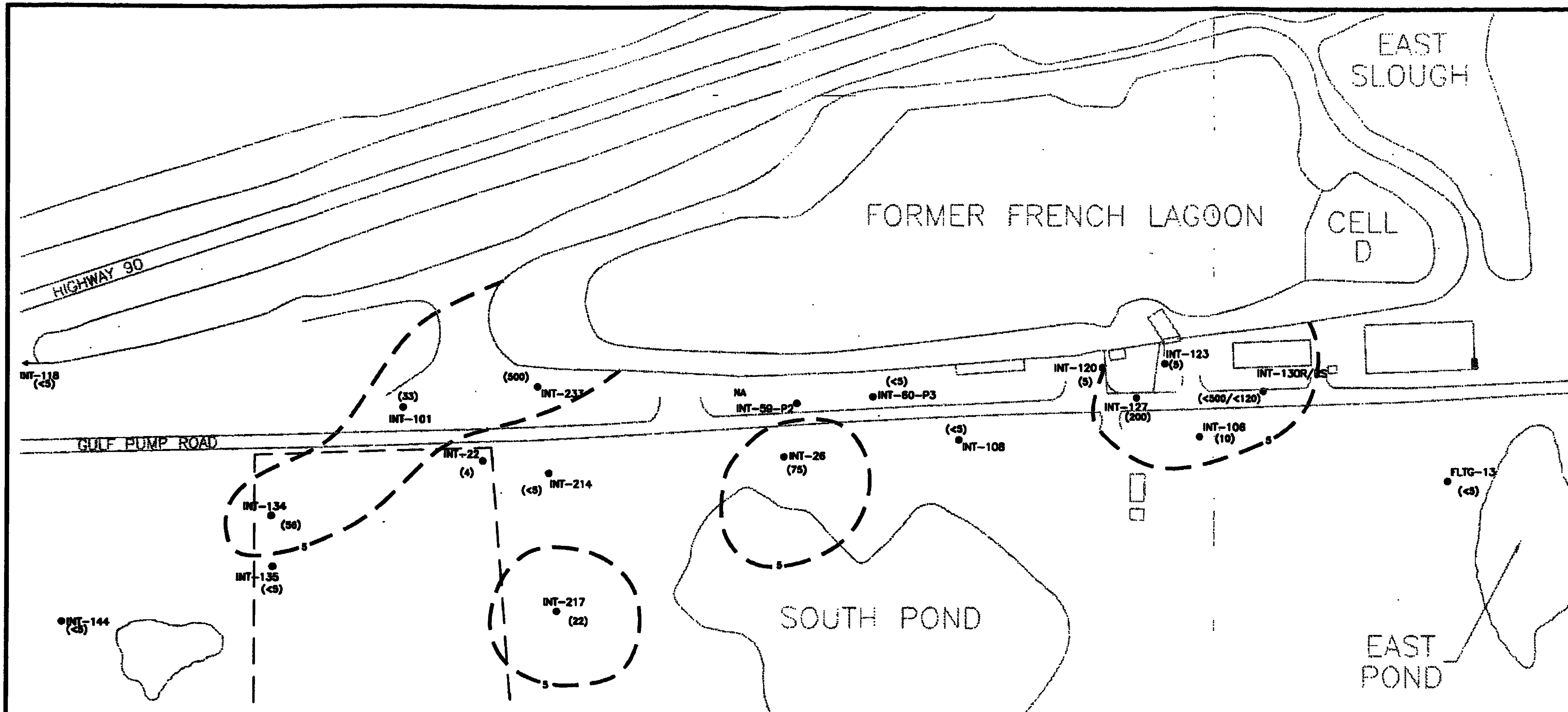


FIGURE 2-10
TOC
S1 UNIT
OCTOBER 1996



EAST SLOUGH
FORMER FRENCH LAGOON
CELL D
HIGHWAY 90
GULF PUMP ROAD
SOUTH POND
EAST POND
INT-118 (1.4)
INT-101 (12.3)
INT-233 (98.9)
NA INT-59-P2
NA INT-60-P3
INT-120 (2.6)
INT-123 (4.2)
INT-130R/RS (11.9/15.9)
INT-127 (76.3)
INT-106 (23.6)
INT-108 (4.6)
INT-26 (34.1)
INT-22 (4.1)
INT-214 (2.5)
INT-134 (34.1)
INT-135 (11.8)
INT-217 (53.8)
INT-144 (<1)
FLTG-14 (3.4)
LEGEND
INT MONITORING WELL
(<0.8) TOC (ppm)
NA NOT ANALYZED
TOC CONTOUR (ppm)
150' 0 150'
SCALE IN FEET
N
Applied Hydrology Associates, Inc.
FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-11
TOC
INT UNIT
OCTOBER 1996
KSC
KSC
JAMT
6/30/94
1"=150'
FRENCH.DWG


S1-118 (<5)
SLOUGH
FORMER FRENCH LAGOON
CELL D
S1-126
S1-64
S1-131 (32)
S1-119
S1-121 (<5)
S1-105
S1-123 (<5)
P-6
P-5
S1-31 (<5)
ROAD
S1-108A (<5)
S1-106A (<5)
S1-33 (<5)
S1-51-P3A (<5)
S1-111 NA
FLTG-14 (<5)
S1-106R (25)
S1-135 (<5)
SOUTH POND
EAST POND
5
LEGEND
S1 MONITORING WELL
(<0.3) BENZENE (ppb)
NA NOT ANALYZED
5 BENZENE CONTOUR (ppb)
150' 0 150'
SCALE IN FEET
N
Applied Hydrology Associates, Inc.
5 11/27/96 REVISION KR JAMT JAMT
4 9/9/96 REVISION AB
3 2/9/96 REVISION KR JAMT JAMT
2 10/9/95 REVISION KR JAMT JAMT
NO. DATE REVISION DRAWN CHECKED APPROVED
FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-12
BENZENE
S1 UNIT
OCTOBER 1996
KSC 6/30/94
KSC AS SHOWN
JAMT
FRENCH.DWG
1 OF 1



LEGEND

- ● INT MONITORING WELL
- (<0.8) BENZENE (ppb)
- NA NOT ANALYZED
- —5— BENZENE CONTOUR (ppb)

150' 0 150'
SCALE IN FEET

N

Applied Hydrology Associates, Inc.

NO.	DATE	REVISION	DRAWN	CHECKED	APPROVED
7	11/26/96	UPDATES	KR	JAMT	JAMT
6	9/12/96	REVISION	AB		
5	6/13/96	APRIL 96 WATER LEVEL	AB		
4	2/9/96	REVISE	KR	JAMT	JAMT

FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS

FIGURE 2-13
BENZENE
INT UNIT
OCTOBER 1996

KSC	6/30/94	FRENCH.DWG
KSC	1"=150'	
JAMT		26-01 / 1 OF 1

The maximum benzene concentration in the INT unit is 500 µg/L at INT-233. Benzene was detected above the MCL in four areas:

1. southwest - from INT-134 to INT-233
2. south - at INT-217
3. central - at INT-26
4. east - at INT-127, INT-106, and INT-130R/RS

The elevated benzene areas correspond closely with areas of high TOC and low DO. Therefore, as mentioned in Section 2.4.3, enhanced natural attenuation would be an appropriate response.

2.4.5 1,2-DCA

1,2-DCA contour maps for October 1996 are presented in Figures 2-14 and 2-15. 1,2-DCA was not detected in the S1 unit above the MCL (5 µg/L). This is a significant reduction from July 1996, mainly due to the change at S1-123 from 19,000 to 4 µg/L.

The maximum 1,2-DCA concentration in the INT unit is 450 µg/L at INT-130R. 1,2-DCA was detected above the MCL in two areas, which are similar to July 1996:

1. southwest - at INT-134
2. east - at INT-120, INT-123, INT-106, and INT-130R/RS

The elevated 1,2-DCA areas correspond closely with areas of high TOC and low DO. Therefore, enhanced natural attenuation would be an appropriate response.

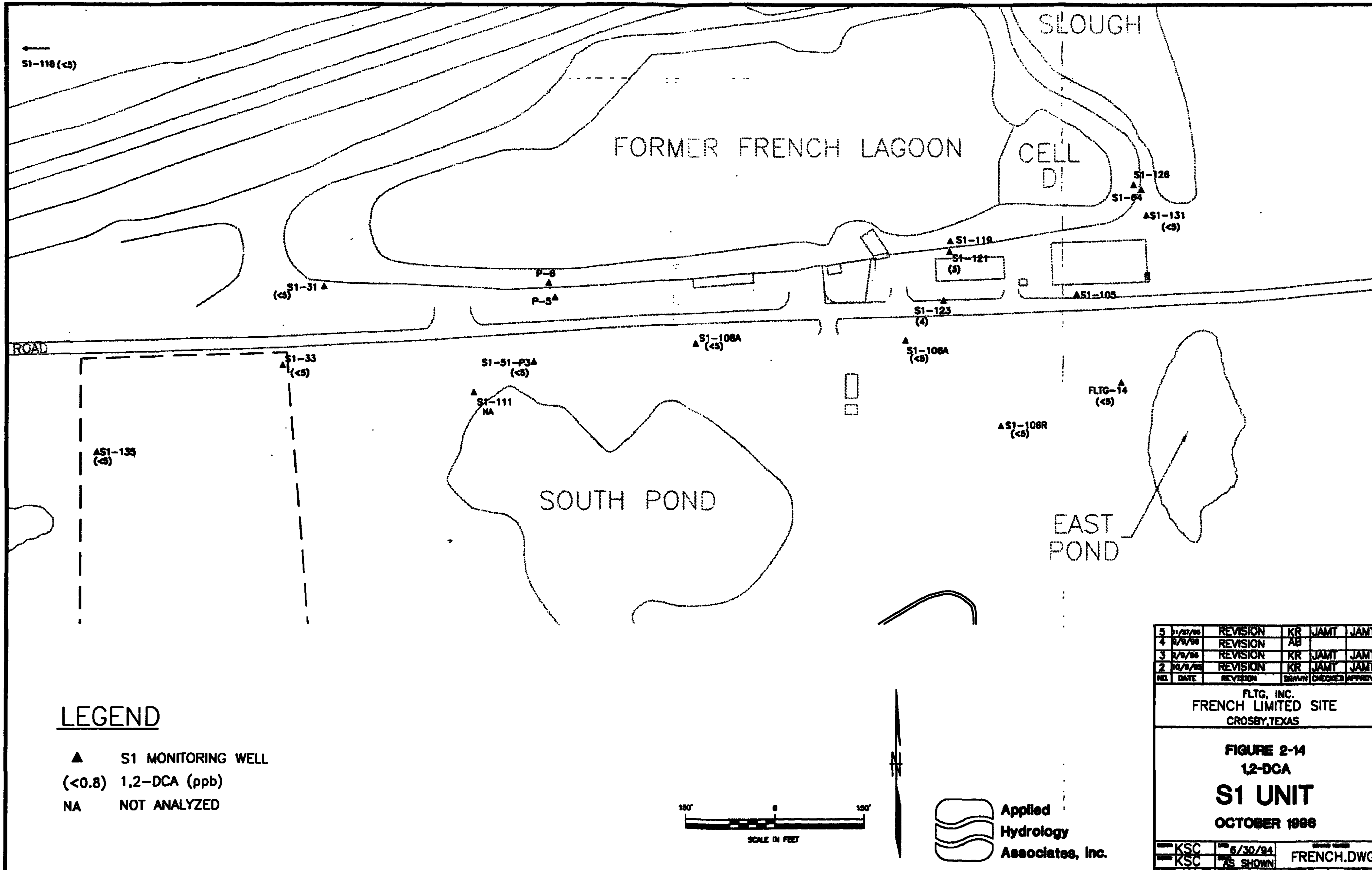
2.4.6 Vinyl chloride

Vinyl chloride contour maps for October 1996 are presented in Figures 2-16 and 2-17. The maximum vinyl chloride concentration in the S1 unit is 21 µg/L at S1-123. Vinyl chloride was detected above the MCL (2 µg/L)[9] only at S1-123, which is in the east area of high TOC and low DO. This is a significant reduction from July 1996, mainly due to the change at S1-123 from 2,600 to 21 µg/L.

The maximum vinyl chloride concentration in the INT unit is 190 µg/L at INT-134. Vinyl chloride was detected above the MCL in two areas, similarly to July 1996:

1. southwest - at INT-134
2. south- at INT-217
3. east - at INT-130R/RS

[9] Note that the detection limit for most of the wells reported was 10 µg/L.

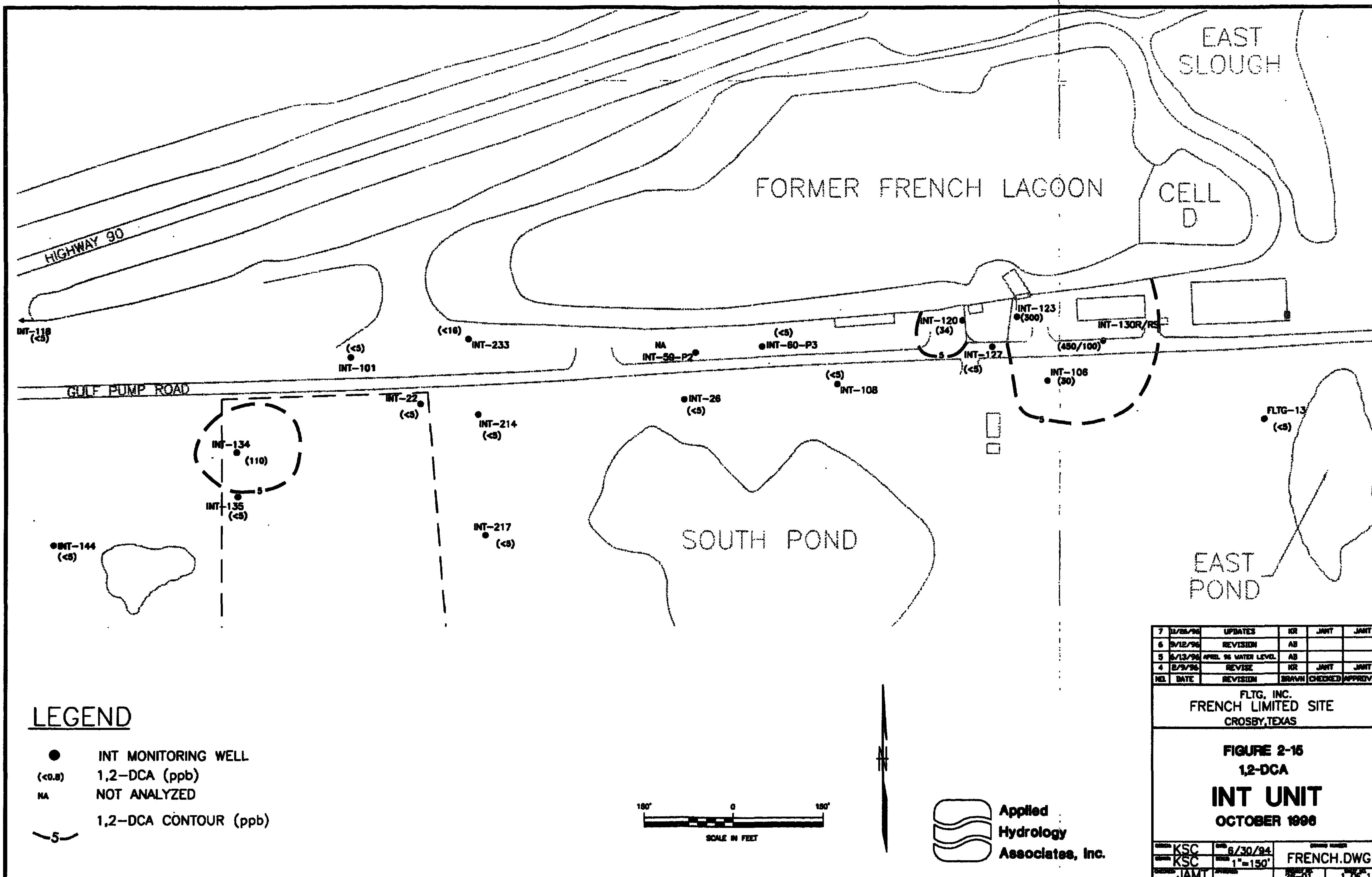


NO.	DATE	REVISION	DRAWN	CHECKED	APPROVED
5	11/27/96	REVISION	KR	JAMT	JAMT
4	9/9/96	REVISION	AB		
3	2/9/96	REVISION	KR	JAMT	JAMT
2	10/9/95	REVISION	KR	JAMT	JAMT

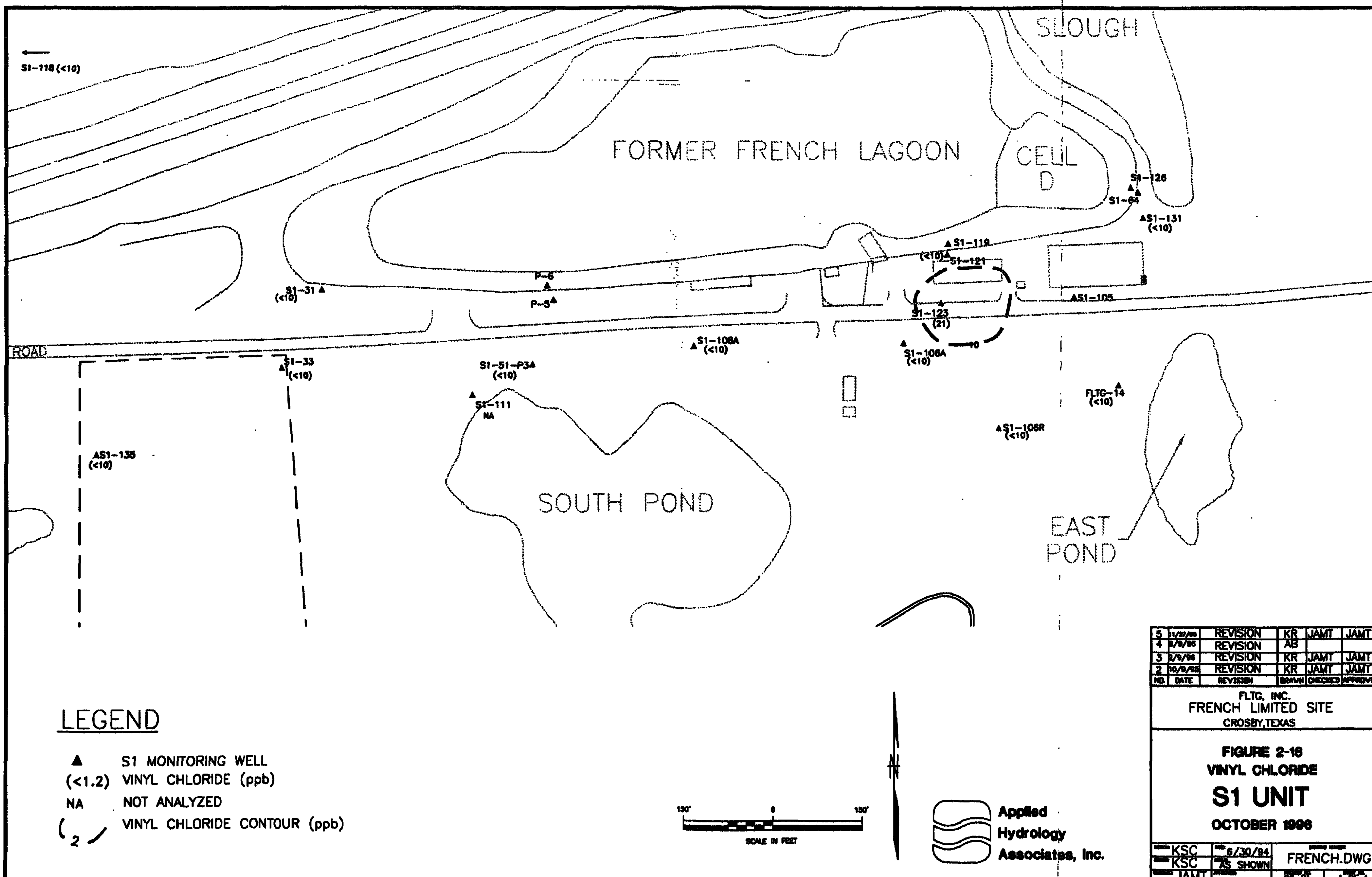
FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS

FIGURE 2-14
1,2-DCA
S1 UNIT
OCTOBER 1996

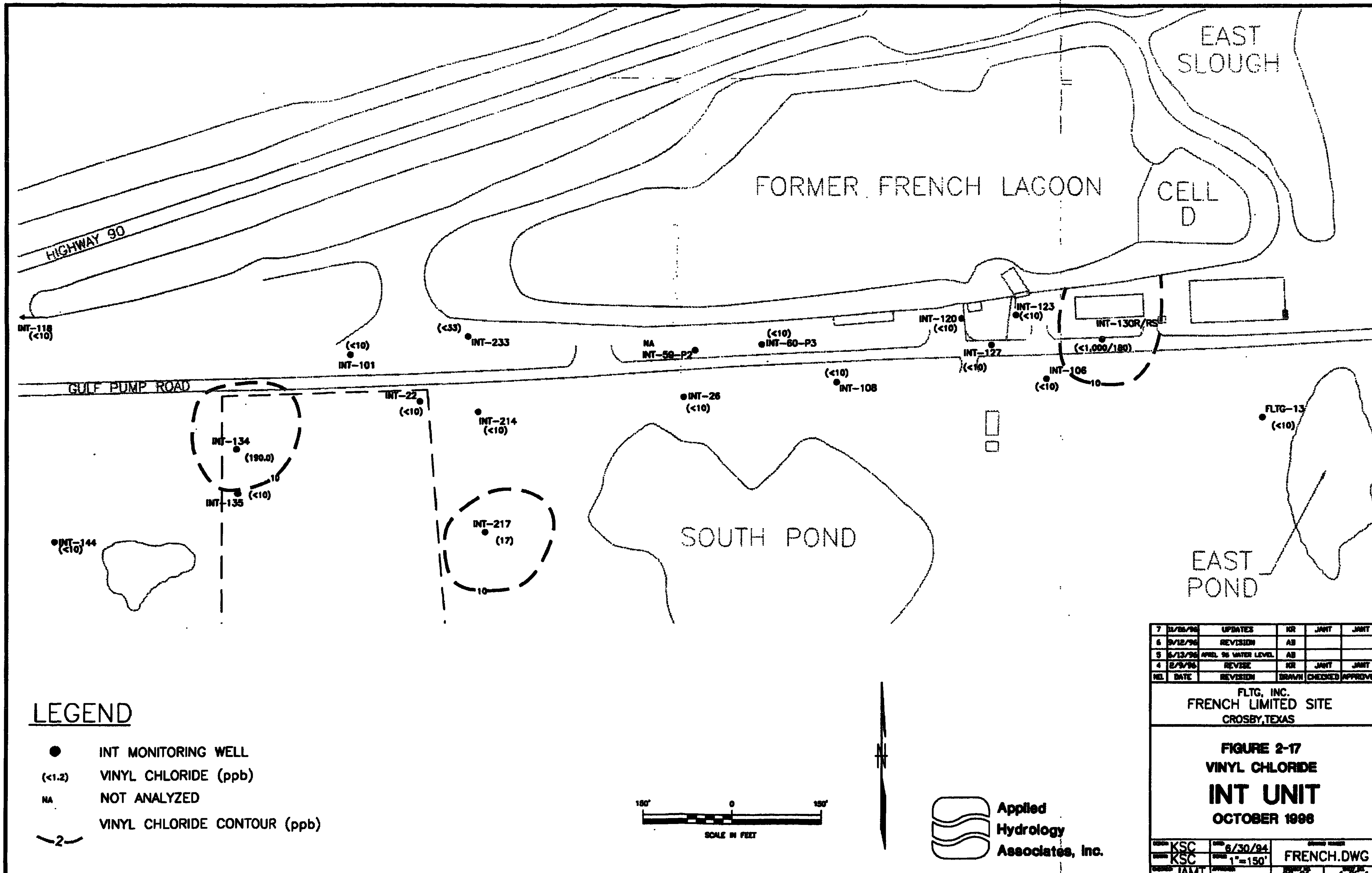
KSC	6/30/94	FRENCH.DWG
KSC	AS SHOWN	
JAMT		26-01 / 1 OF 1



EAST SLOUGH
FORMER FRENCH LAGOON
CELL D
HIGHWAY 90
GULF PUMP ROAD
SOUTH POND
EAST POND
INT-118 (<5)
INT-101 (<5)
INT-233 (<16)
INT-59-P2 NA
INT-60-P3 (<5)
INT-120 (34)
INT-123 (300)
INT-130R/RS (450/100)
INT-127 (<5)
INT-108 (<5)
INT-106 (30)
INT-26 (<5)
INT-22 (<5)
INT-214 (<5)
INT-134 (110)
INT-135 (<5)
INT-217 (<5)
INT-144 (<5)
FLTG-13 (<5)
5
LEGEND
INT MONITORING WELL
(<0.8) 1,2-DCA (ppb)
NA NOT ANALYZED
5 1,2-DCA CONTOUR (ppb)
150' 0 150'
SCALE IN FEET
N
Applied Hydrology Associates, Inc.
7 11/26/96 UPDATES KR JAMT JAMT
6 9/12/96 REVISION AB
5 6/13/96 APRIL 96 WATER LEVEL AB
4 2/9/96 REVISE KR JAMT JAMT
NO. DATE REVISION DRAWN CHECKED APPROVED
FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-15
1,2-DCA
INT UNIT
OCTOBER 1996
KSC 6/30/94
KSC 1"=150'
JAMT
FRENCH.DWG
1 OF 1



S1-118 (<10)
SLOUGH
FORMER FRENCH LAGOON
CELL D
S1-126
S1-64
S1-131 (<10)
S1-119 (<10)
S1-121
S1-105
S1-31 (<10)
P-6
P-5
S1-123 (21)
10
ROAD
S1-108A (<10)
S1-106A (<10)
S1-33 (<10)
S1-51-P3 (<10)
S1-111 NA
FLTG-14 (<10)
S1-106R (<10)
S1-135 (<10)
SOUTH POND
EAST POND
LEGEND
S1 MONITORING WELL
(<1.2) VINYL CHLORIDE (ppb)
NA NOT ANALYZED
2 VINYL CHLORIDE CONTOUR (ppb)
150' 0 150'
SCALE IN FEET
N
Applied Hydrology Associates, Inc.
5 REVISION KR JAMT JAMT
4 9/9/96 REVISION AB
3 2/9/96 REVISION KR JAMT JAMT
2 10/9/95 REVISION KR JAMT JAMT
NO. DATE REVISION DRAWN CHECKED APPROVED
FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-16
VINYL CHLORIDE
S1 UNIT
OCTOBER 1996
KSC 6/30/94
KSC AS SHOWN
JAMT
FRENCH.DWG
26-01 1 OF 1



EAST SLOUGH
FORMER FRENCH LAGOON
CELL D
HIGHWAY 90
GULF PUMP ROAD
SOUTH POND
EAST POND
INT-118 (<10)
(<10) INT-101
(<33) INT-233
NA INT-59-P2
(<10) INT-60-P3
INT-120 (<10)
INT-123 (<10)
INT-130R/RS
(<1,000/180)
INT-127 (<10)
(<10) INT-108
INT-106 (<10)
INT-22 (<10)
INT-214 (<10)
INT-26 (<10)
FLTG-13 (<10)
INT-134 (190.0)
INT-135 (<10)
INT-217 (17)
INT-144 (<10)
10
LEGEND
INT MONITORING WELL
(<1.2) VINYL CHLORIDE (ppb)
NA NOT ANALYZED
2 VINYL CHLORIDE CONTOUR (ppb)
150' 0 150'
SCALE IN FEET
N
Applied Hydrology Associates, Inc.
7 11/26/96 UPDATES KR JAMT JAMT
6 9/12/96 REVISION AB
5 6/13/96 APRIL 96 WATER LEVEL AB
4 8/9/96 REVISE KR JAMT JAMT
NO. DATE REVISION DRAWN CHECKED APPROVED
FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-17
VINYL CHLORIDE
INT UNIT
OCTOBER 1996
KSC 6/30/94
KSC 1"=150'
JAMT
FRENCH.DWG
28-01
1 OF 1

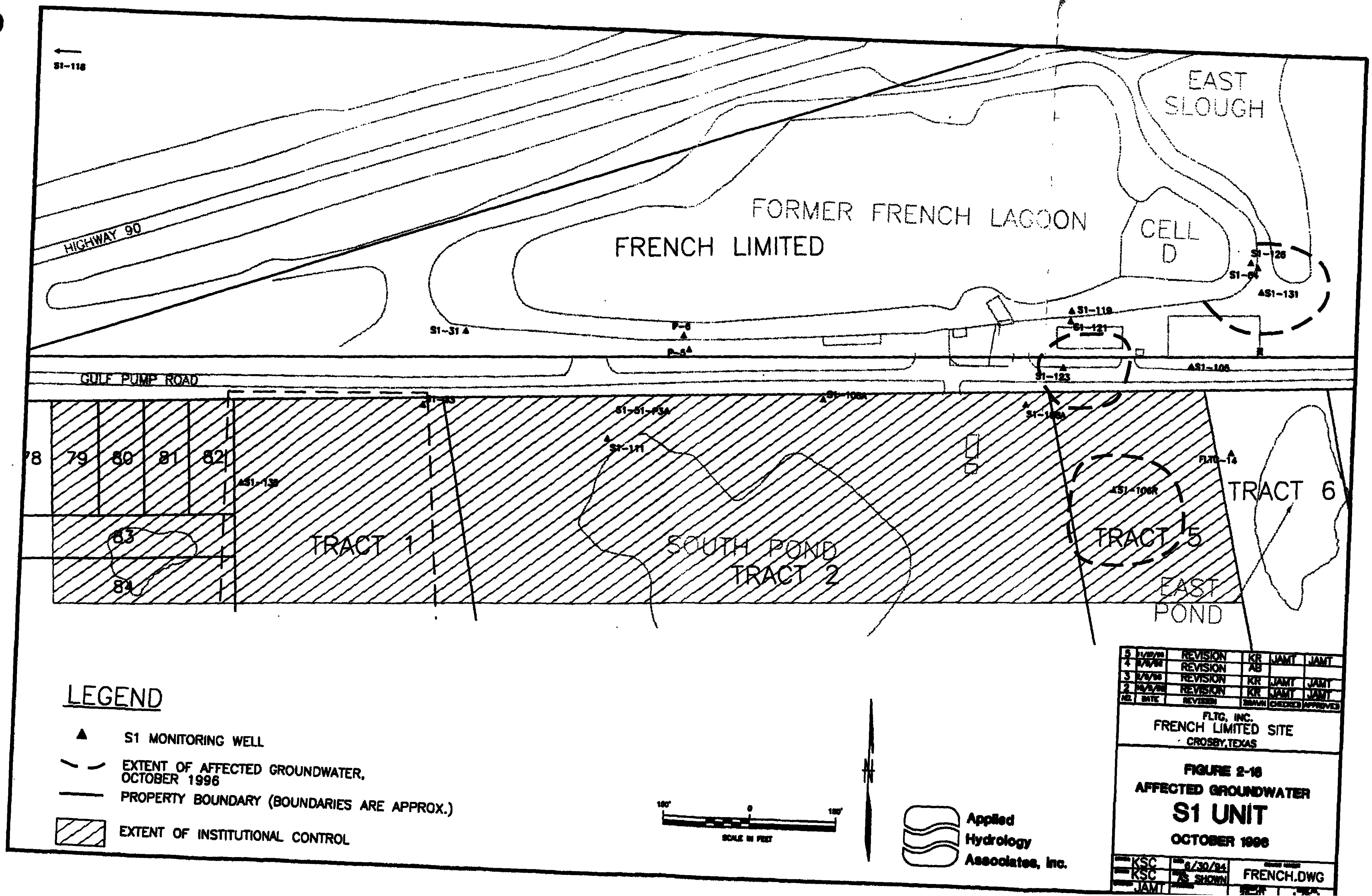
The elevated vinyl chloride areas correspond closely with areas of high TOC and low DO. Therefore, enhanced natural attenuation would be an appropriate response.

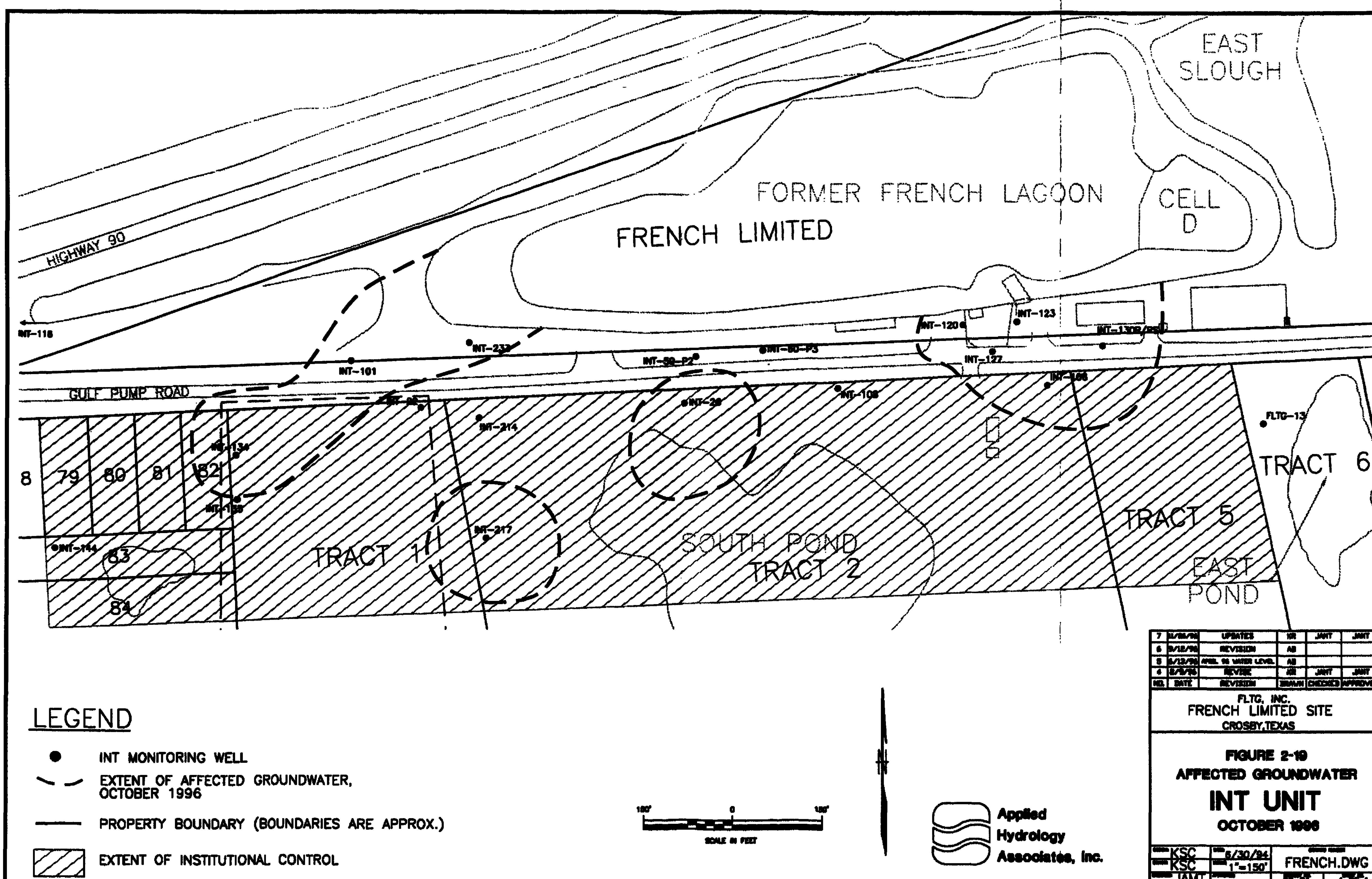
2.4.7 Affected groundwater

Affected groundwater maps for October 1996 are presented in Figures 2-18 and 2-19. These maps superimpose the areas above MCL for benzene, 1,2-DCA, and vinyl chloride. Comparison with Figures 2-8 through 2-11 confirms that the affected areas correspond closely with areas of high TOC and low DO. Therefore, enhanced natural attenuation would be an appropriate response.

Figures 2-18 and 2-19 also show "boundaries of areas subject to institutional controls" which are controlled by FLTG. These areas generally coincide with the areas of elevated chemicals, high TOC, and low DO.

The affected S1 and INT groundwater does not represent a threat to the public health or the environment. FLTG continues to control all property that currently contains elevated concentrations of chemicals in groundwater.


S1-118
EAST SLOUGH
HIGHWAY 90
FORMER FRENCH LAGOON
FRENCH LIMITED
CELL D
S1-126
S1-64
AS1-131
S1-119
S1-121
S1-31
P-6
P-5
GULF PUMP ROAD
AS1-106
S1-123
S1-108A
S1-51-FSA
S1-111
78
79
80
81
82
83
84
AS1-139
TRACT 1
SOUTH POND
TRACT 2
FLTG-14
AS1-106R
TRACT 5
TRACT 6
EAST POND
LEGEND
S1 MONITORING WELL
EXTENT OF AFFECTED GROUNDWATER, OCTOBER 1996
PROPERTY BOUNDARY (BOUNDARIES ARE APPROX.)
EXTENT OF INSTITUTIONAL CONTROL
SCALE IN FEET
N
Applied Hydrology Associates, Inc.
REVISION
REVISION
REVISION
REVISION
FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-16
AFFECTED GROUNDWATER
S1 UNIT
OCTOBER 1996
KSC
KSC
JAMT
6/30/94
AS SHOWN
FRENCH.DWG


EAST SLOUGH
FORMER FRENCH LAGOON
CELL D
FRENCH LIMITED
HIGHWAY 90
GULF PUMP ROAD
INT-118
INT-101
INT-232
INT-59-P2
INT-60-P3
INT-120
INT-123
INT-127
INT-106
INT-214
INT-134
INT-217
INT-144
FLTG-13
8
79
80
81
82
83
84
TRACT 1
SOUTH POND
TRACT 2
TRACT 5
TRACT 6
EAST POND
N
LEGEND
INT MONITORING WELL
EXTENT OF AFFECTED GROUNDWATER, OCTOBER 1996
PROPERTY BOUNDARY (BOUNDARIES ARE APPROX.)
EXTENT OF INSTITUTIONAL CONTROL
150' 0 150'
SCALE IN FEET
Applied Hydrology Associates, Inc.
FLTG, INC.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-19
AFFECTED GROUNDWATER
INT UNIT
OCTOBER 1996
KSC
KSC
JAMT
6/30/94
1"=150'
FRENCH.DWG

SECTION 3.0

3.0 Natural attenuation modeling update

3.1 Background

Demonstration modeling results were presented in the *Natural Attenuation Modeling Report*. This modeling work is referred to here as the "1995 model". In the present report, previous modeling efforts are revised in light of the October, 1996 sampling results. This is referred to here as the "1996 model".

As before, natural attenuation modeling used a two-stage approach. In the first stage, a flow model was used to predict the long-term groundwater velocity field. In the second stage, a contaminant fate model was used to predict natural attenuation processes. This approach is summarized in the following table:

Natural attenuation phenomenon	Modeled using	Notes
advective transport	flow model (VMODFLOW©)	long-term flow simulated
hydrodynamic dispersion	contaminant fate model (BioTrans©)	mechanical dispersion and diffusion
retardation		adsorptive-desorptive interaction between dissolved species in groundwater and aquifer matrix material
intrinsic bioremediation of hydrocarbons		limited by electron acceptor (e.g., oxygen) availability

Details of the 1996 model, and differences from the 1995 model, are presented below.

3.1.1 Flow model

There were no changes made to the 1995 flow model. The velocity values generated using VMODFLOW© for the 1995 model were used. Measured groundwater levels and gradients during the natural attenuation period are consistent with the 1995 flow model predictions.

3.1.2 Natural attenuation model

BioTrans© was used, as in the 1995 model. However, during 1996, the BioTrans© authors, ES&T of Blacksburg, Virginia, revised the model code from version 1.13 (August 1995) to 1.21 (April 1996), 1.25 (July 1996), and 1.26 (August 1996). These changes modified the way that the model handles such items as groundwater velocity, dispersivity, boundary inflow and concentrations, oxygen injection, oxygen degradation, mobile/immobile mass transfer, input units, and output format. As a result, the program now behaves slightly differently from earlier versions, which required some changes in model assumptions and variables. These changes are described below. As a result, results of the 1996 model cannot be directly compared with results of the 1995 model.

3.1.3 Hybrid approach to starting condition

A major influence on model results is the starting condition, i.e., the initial distribution of the five variables to be modeled (DO, TOC, benzene, 1,2-DCA, and vinyl chloride). For the 1996 model, this was determined in a different way from that used in the 1995 model.

A different approach was justified, because the 1995 starting condition was based on groundwater sampling data from 234 data points: groundwater results from 84 monitoring wells, TOC data from 97 production wells, and inferred DO data from 53 injection wells, not including wells inside the cutoff wall. By contrast, 38 wells were retained for progress monitoring, of which 31 are used to sample for VOCs.

Because of the reduction in the number of data points, three options were evaluated for updating predictive "demonstration" modeling runs using the latest available field data:

Type	Start date	End date	Time	Comments
Normal - 10 years	1995	2005	10 years	Ignores latest available field data (October 1996).
Normal - 9 years	1996	2005	9 years	Ignores data that could be inferred from October 1995 results.
Hybrid - part 1	(Part 1) 1995	1996	1 year	Uses end-of-run predicted values, combined with October 1996 field data, to create starting condition for part 2.
part 2	(Part 2) 1996	2005	9 years	

The hybrid option was selected as providing the best combination that took all available data into account.

Using the hybrid option for the 1996 modeling, the following sequence was observed:

1. Set up the model using 1995 starting conditions (the same as for the 1995 demonstration modeling).
2. Run the model for one year, generating predicted 1996 results.
3. Compare these results with the results of field sampling. If in general agreement, this indicates that the original model was satisfactory calibrated.
4. Convert the predicted 1996 results to point values (X, Y, C) for the same 230 well points that were used to generate the 1995 starting conditions.
5. Add the 1996 field results, where available, to the point-value database.

6. Contour and grid the point values using SURFER©.
7. Use the gridded data to represent 1996 starting conditions.
8. Run the model for a further nine years, i.e., to 2005.

The October 1996 data used is presented in full in Appendix A and is summarized in Section 2.0.

3.2 Flow modeling

As described in Section 3.1, there were no changes made to the 1995 flow model. Details of the 1995 flow modeling are in the *Natural Attenuation Modeling Report*. A brief description of model inputs is presented below.

3.2.1 Boundary conditions

The entire San Jacinto shallow alluvial aquifer was modeled to produce long-term, steady-state, hydraulic gradients and flow velocities (Figure 3-1). Upgradient (north) and downgradient (south) model boundaries were fixed-head boundaries set based on long-term hydraulic gradients measured at the site before active remediation was started. East and west boundaries of the aquifer were based on mapped geologic contacts with the underlying and adjacent Beaumont Clay aquitard. These contacts were modeled as impermeable boundaries, as was the cutoff wall, which extends through the shallow alluvial aquifer into the Beaumont clay.

It was assumed that there would be no significant vertical groundwater migration between the upper (S1) and lower (INT) shallow alluvial aquifer units under long-term dynamic equilibrium. Therefore, they both were modeled in the same manner. The flow model was run for steady-state, with zero recharge.

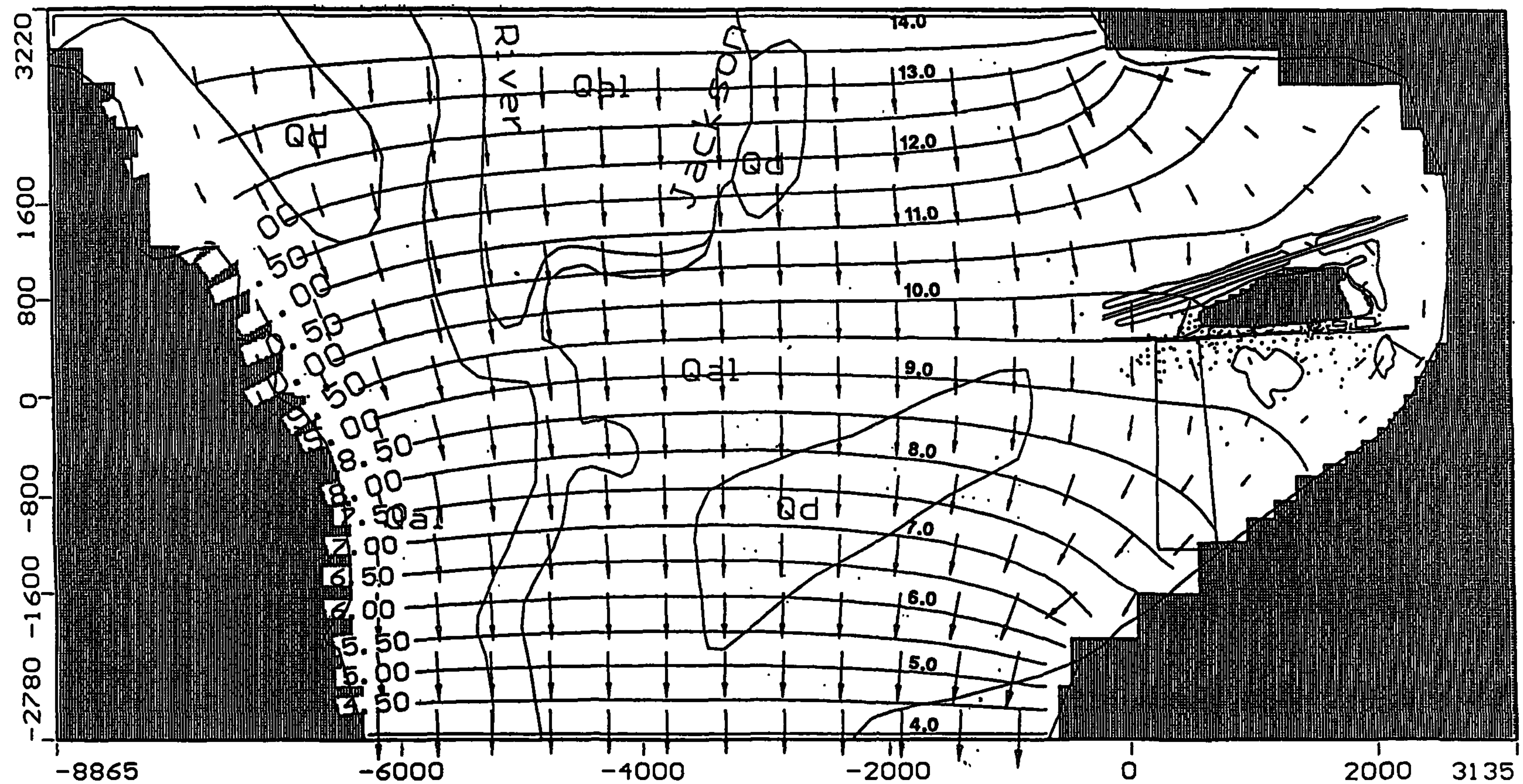
3.2.2 Aquifer parameters

The following aquifer properties were used:

Unit	Top Contact (ft-MSL)	Thickness (ft)	Horizontal permeability (ft/day)	Storage coefficient type	Storage coefficient
UNC	15.0	10.0	1.0	specific yield	0.1
S1	5.0	20.0	20.0	specific storage	0.00001/ft
C1	-15.0	5.0	1.0	specific storage	0.00001/ft
INT	-20.0	20.0	5.0	specific storage	0.00001/ft
C2	-40.0	modeled as impermeable base			

Figure 3-1

Regional flow model



ELEVATION - FT-MSL

3.2.3 Model calibration

Groundwater elevation measurements collected as part of the long-term monitoring program for the site will be used to provide ongoing flow model calibration. As described in Section 2.0, it is intended to use monthly water-level measurements in future, to generate average annual groundwater level contours, thereby eliminating short-term, localized water-level changes.

3.2.4 Model areas

The site was modeled as four subareas, each of which did not meet compliance criteria in October 1995. The same areas did not meet compliance criteria in October 1996. These areas are:

1. INT west
2. INT central
3. INT-11 wall
4. S1 east

Model area locations are shown in Figure 3-2.

3.2.5 Model results

Flow model results are shown in Figures 3-3 through 3-6. These figures show the groundwater elevation contours and relative velocity vectors for the four modeled areas. Figure 3-6 is a key to the well symbols used in this report.

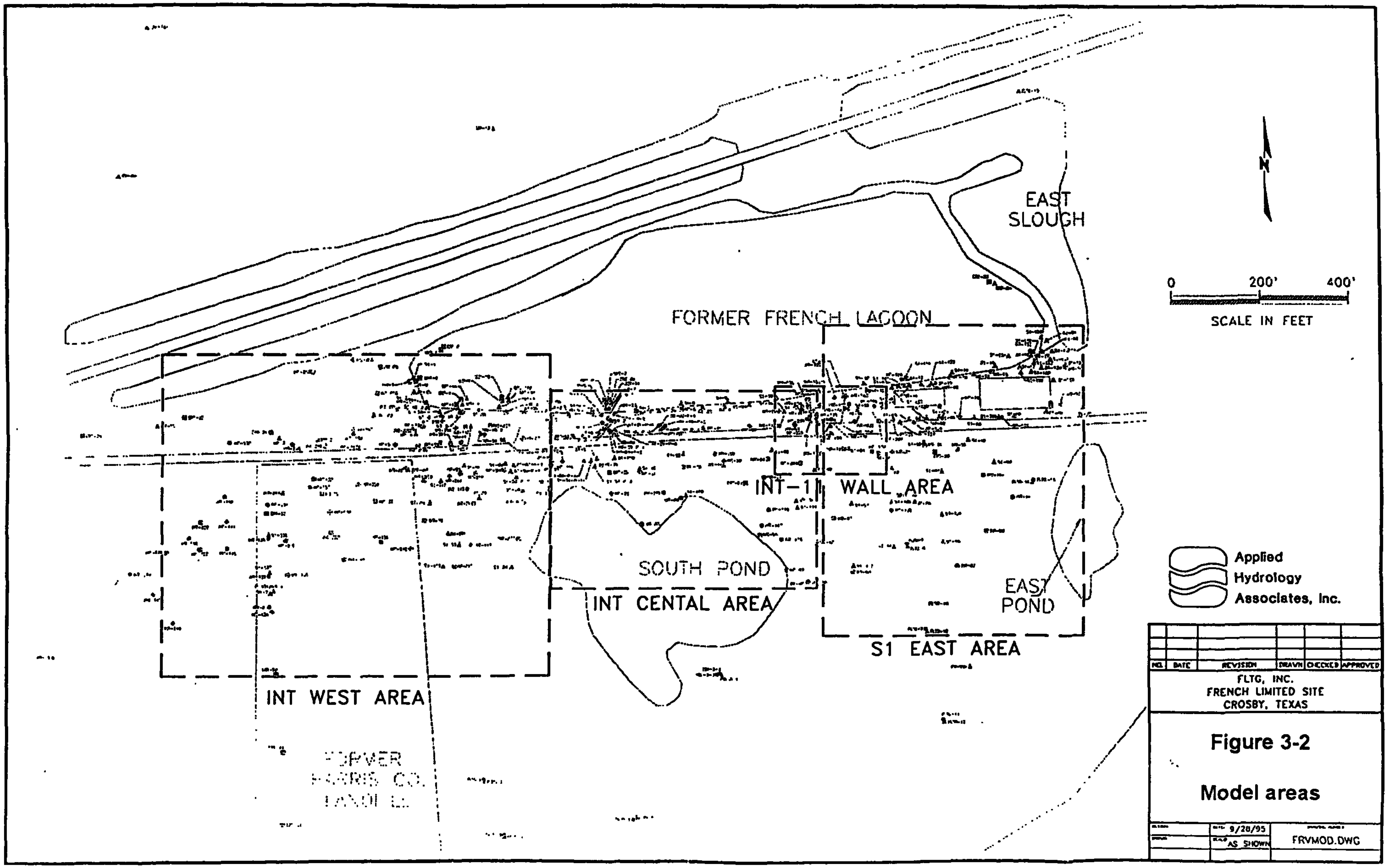


Figure 3-2

Model areas

Figure 3-3

INT west flow model

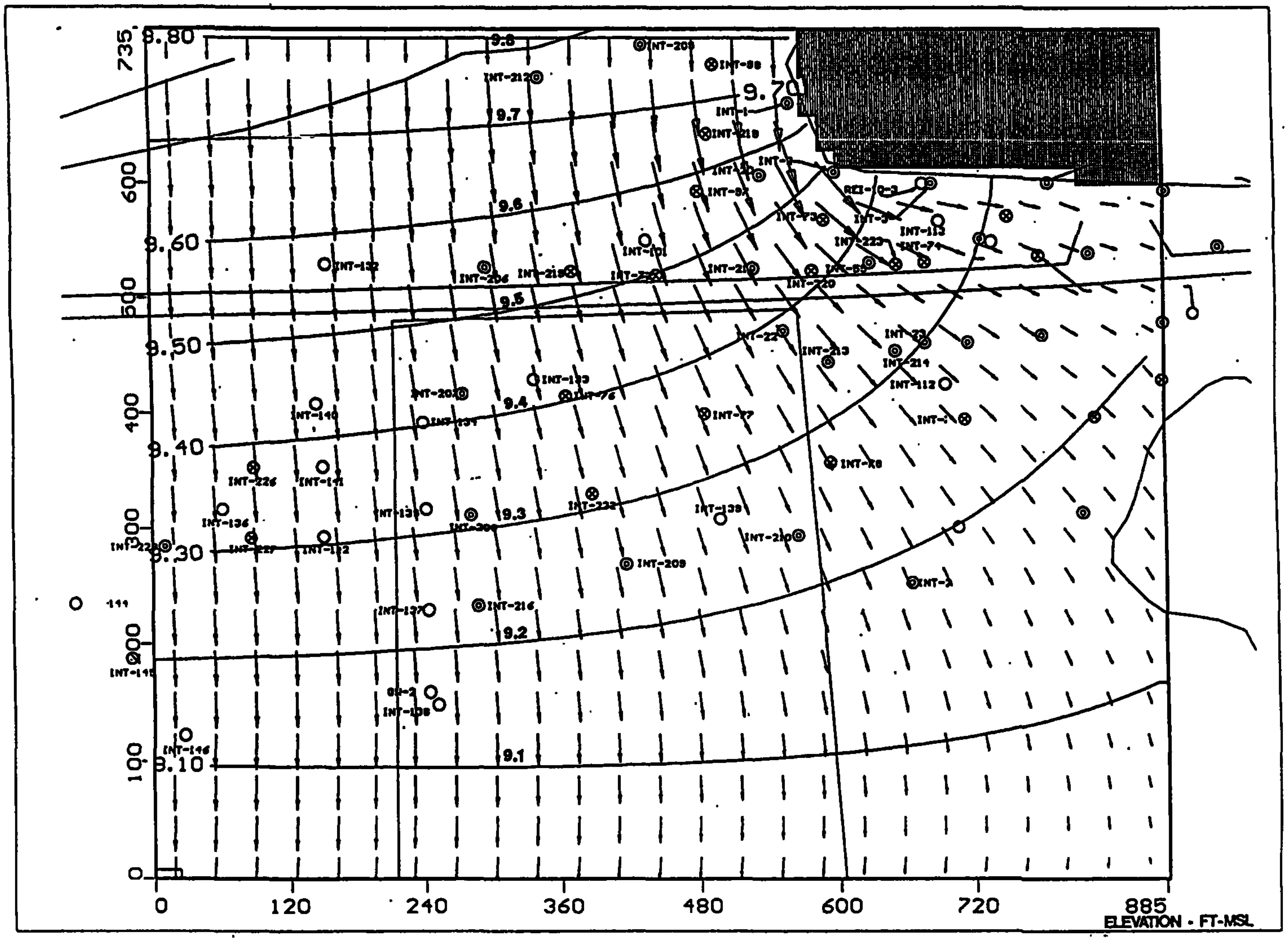


Figure 3-4

INT central flow model

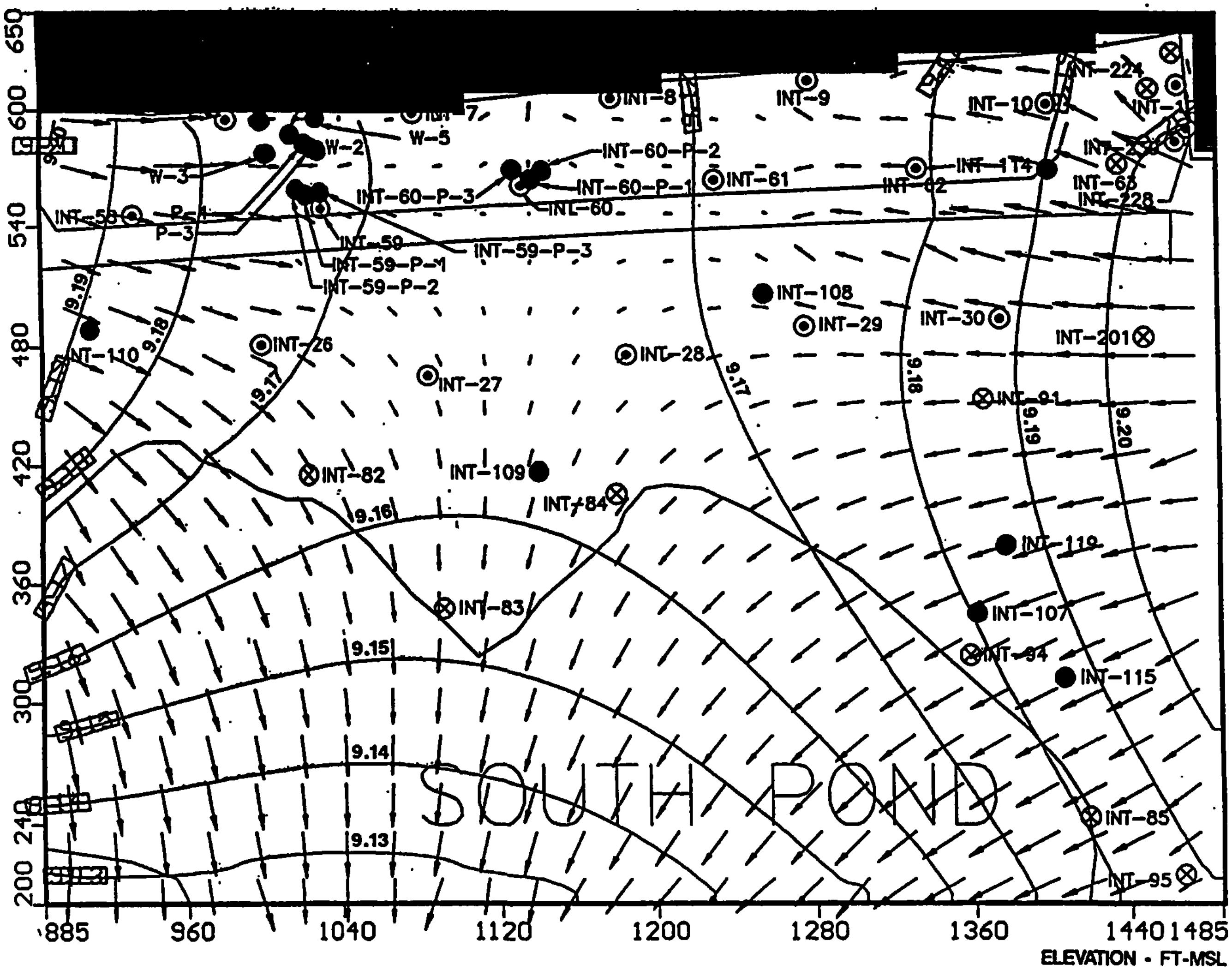


Figure 3-5

INT wall flow model

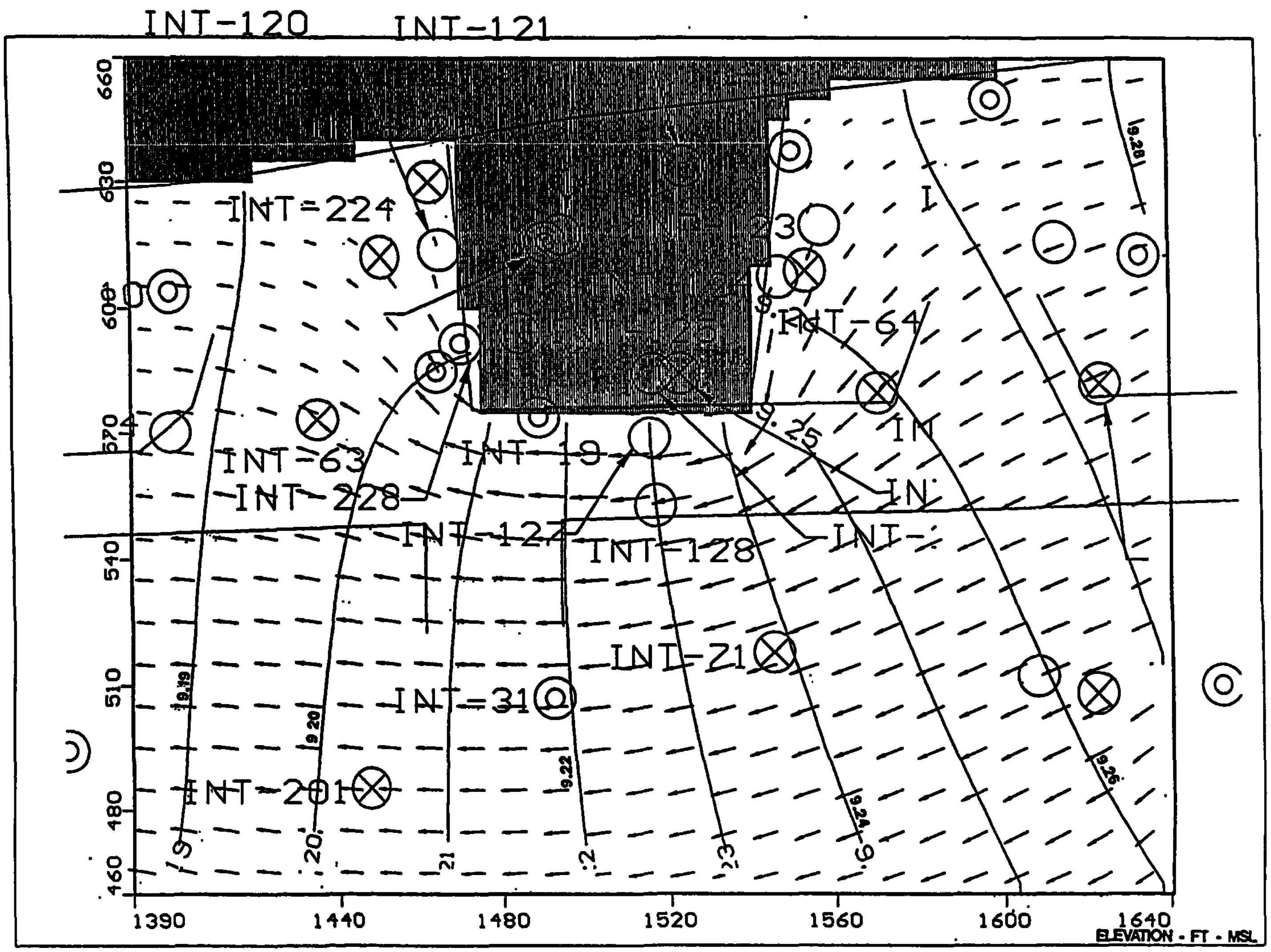


Figure 3-6

S1 east flow model

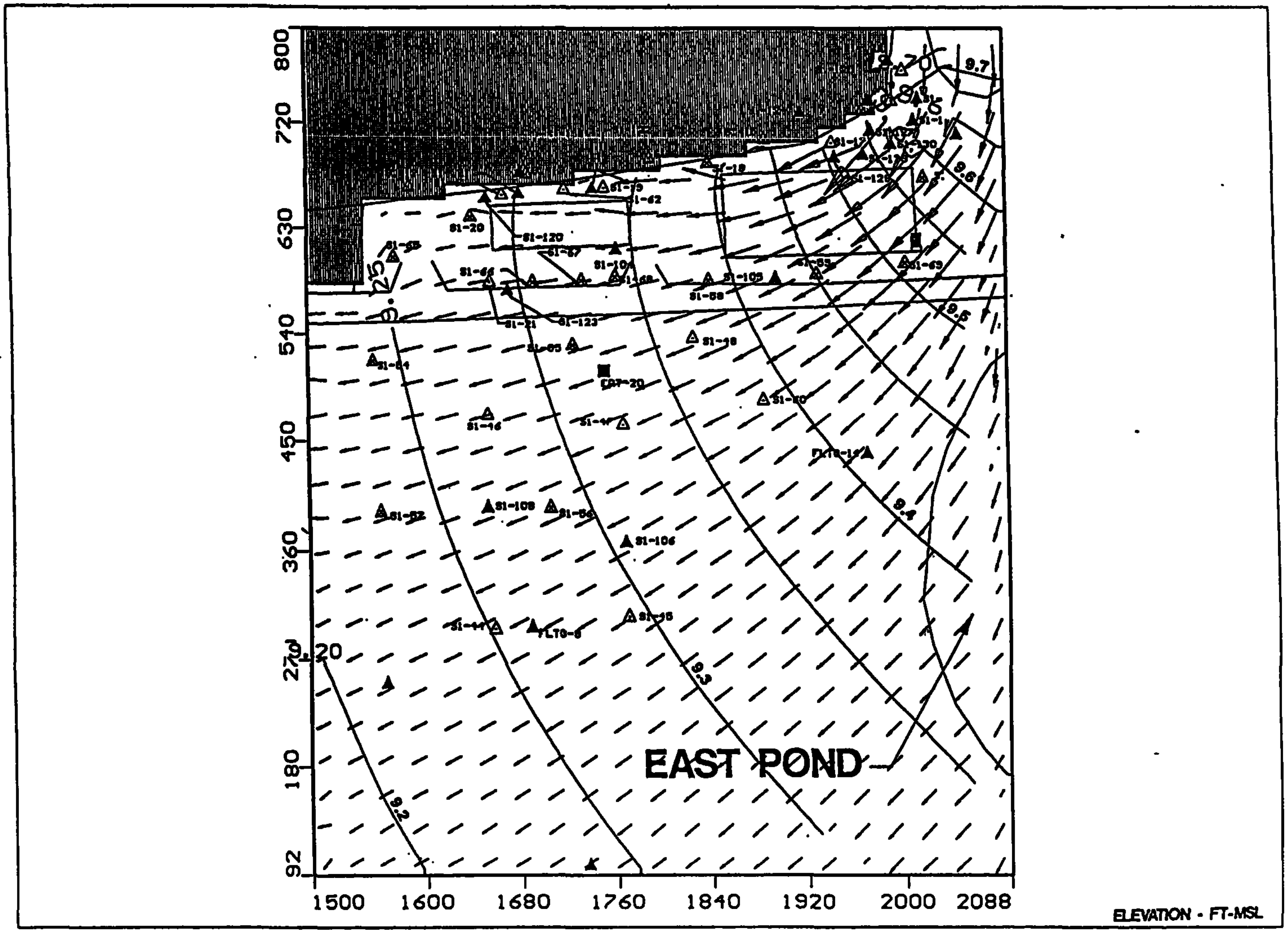
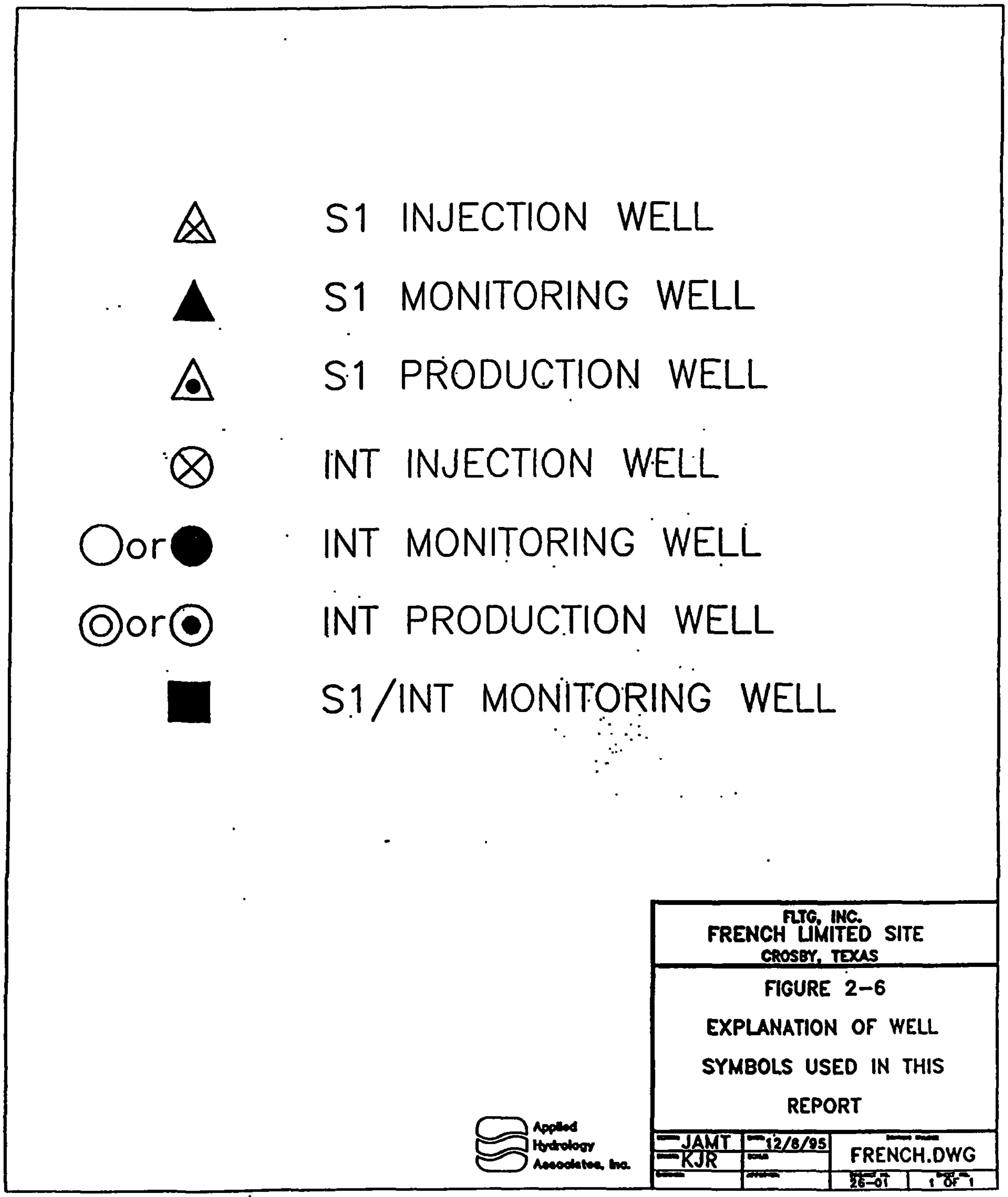


Figure 3-7

Explanation of well symbols used in this report



3.3 Natural attenuation modeling

3.3.1 Model stability and sensitivity

Model stability and sensitivity were not re-evaluated for the 1996 model. It was not considered necessary to repeat the stability modeling, as dispersivity, model grid spacing, and timestep, the three parameters affecting model stability, were unchanged in the 1996 model. A full description of model stability is presented in the *Natural Attenuation Modeling Report*. It was not considered necessary to repeat sensitivity modeling because model sensitivities had already been determined. A full description of model sensitivity is presented in the *Natural Attenuation Modeling Report*.

3.3.2 Initial conditions

Initial conditions for the natural attenuation model were established by using the hybrid approach described in Section 3.1.3.

3.3.3 Input parameters

The following tables summarize the input parameters used in BioTrans demonstration simulations. A detailed description of model parameters is presented in the *Natural Attenuation Modeling Report*. Values used are generally the same as those selected for 1995 model. Changes are discussed below.

Input Parameter	Unit	INT west	INT central	INT wall	S1 east
Grid spacing	ft	15	10	5	12
Time step	day	50	50	50	50
Half life	day	60	60	60	60
Initial DO/nitrate (as equivalent DO or "DO+")	ppm	9/95 values	9/95 values	9/95 values	9/95 values
Longitudinal dispersivity	ft	17.5	17.5	17.5	61
Transverse dispersivity	ft	1.75	1.75	1.75	6.1
DO stoichiometry	-	2.75	2.75	2.75	2.75
f_{oc}	%	0.15%	0.15%	0.15%	0.15%
Effective porosity	-	0.2	0.2	0.2	0.25
Non-biodegradable TOC	%	75%	75%	75%	75%

The only change from the 1995 model is the increase in the percentage of non-biodegradable TOC from 50% to 75%. This change was made in response to initial model results using 50% non-biodegradable TOC; in these runs, predicted DO after one year was significantly less than that measured in the field after one year. An increase to 75% non-biodegradable TOC gave a better match with actual field conditions.

The following parameters define the properties of the simulated chemical species:

Chemical	K_{oc} (mL/g)	K_d at f_{oc} = 0.15% (mL/g)
Benzene	83	0.1245
1,2-DCA	33	0.0495
Vinyl chloride	2.5	0.0038
TOC	1,300	1.95

The only change from the 1995 model is the decrease in the K_{oc} of TOC from 1,250,000 mL/g to 1,300 mL/g. The change in K_d from 1,875 mL/g to 1.95 mL/g results from the change in K_{oc}. The 1995 value of K_{oc} was initially recommended by ES&T; subsequently they indicated that this value was too high, in light of modifications they had made to the model code, notably the way the model handles immobile/mobile transfer. As a result, AHA selected the value for naphthalene to represent biodegradable TOC, as naphthalene was historically the most widely-occurring semivolatile compound detected in site groundwater.

3.3.4 Model results

For each of the four model areas, contour maps were generated for DO, TOC, benzene, 1,2-DCA, and vinyl chloride, at three times: initial (1995), 1996, and 2005. These maps are presented in Appendix B. The maps show the following conditions:

Map title	Description	Stage referenced in Section 3.1.3
initial	1995 conditions, i.e., the start of the one-year 1995 to 1996 run	1
1996	results of the one-year run, after incorporating October 1996 sampling results	6
2005	results of the nine-year 1996 to 2005 run	8

Evaluation of the results was performed as follows:

1. Compare results of 1995-1996 run with October 1996 field results
2. Compare results of 2005 run with ROD

3.3.5 Model vs field results

Tables 3-1 through 3-4 present a comparison of concentrations predicted by the 1995-1996 run with the October 1996 groundwater sampling results, for each of the four modeled areas. Note that modeled TOC is non-biodegradable TOC, i.e., approximately 25% of total TOC.

Table 3-1

Model vs field results - INT west area

Well	DO+		TOC		Benzene		1,2-DCA		Vinyl Chloride	
	Model	Field	Model	Field	Model	Field	Model	Field	Model	Field
INT-22	1.53E-06	0.8	5.13	4.1	25.4	4	4.72	<5	6.43	<10
INT-101	0.0337	0.9	8.5	12.5	122	33	0.0036	<5	0.21	<10
INT-134	1.78	6.2	0	34.1	0	56	0	110	0	190
INT-135	36.2	0.8	0	11.8	0	<5	0	<5	0	<10
INT-214	4.5E-06	0.7	6.92	2.5	34.6	<5	2.01	<5	0.00642	<10
INT-217	8.74E-06	1	12.5	53.8	16.4	22	19.5	<5	51.8	17
INT-233	0.000466	0.7	537	98.9	1150	500	0.119	<16	3790	<33

Explanation

< less than
DO+ combined term for dissolved oxygen and nitrate, expressed as equivalent DO (mg/L)
TOC total organic carbon (mg/L)
Benzene, 1,2-DCA, and vinyl chloride data are in µg/L

Table 3-2

Model vs field results - INT central area

Well	DO+		TOC		Benzene		1,2-DCA		Vinyl Chloride	
	Model	Field	Model	Field	Model	Field	Model	Field	Model	Field
INT-26	42.67	0.70	0.00	34.10	0.00	75.00	0.00	0.00	0.00	0.00
INT-60-P3	0.00	240.50	3.43	1.40	28.94	0.00	0.00	0.00	0.00	0.00
INT-108	0.00	0.70	1.05	4.80	1.06	0.00	0.00	0.00	0.00	0.00
INT-120	72.95	53.85	0.00	2.60	0.00	5.00	0.00	34.00	0.00	0.00

Explanation

< less than
DO+ combined term for dissolved oxygen and nitrate, expressed as equivalent DO (mg/L)
TOC total organic carbon (mg/L)
Benzene, 1,2-DCA, and vinyl chloride data are in μg/L

Table 3-3

Model vs field results - INT-11 wall area

Well	DO+		TOC		Benzene		1,2-DCA		Vinyl Chloride	
	Model	Field	Model	Field	Model	Field	Model	Field	Model	Field
INT-106	0.00	0.60	13.10	23.60	2.55	10.00	6.75	30.00	3.28	<10
INT-120	29.43	53.85	0.02	2.60	0.03	5.00	6.15	34.00	0.16	<10
INT-123	120.20	52.25	0.00	4.20	0.00	5.00	0.00	300.00	0.00	<10
INT-127	0.00	0.70	25.68	78.30	50.29	200.00	3.93	<5	0.50	<10

Explanation

< less than
DO+ combined term for dissolved oxygen and nitrate, expressed as equivalent DO (mg/L)
TOC total organic carbon (mg/L)
Benzene, 1,2-DCA, and vinyl chloride data are in µg/L

Table 3-4

Model vs field results - S1 east area

Well	DO+		TOC		Benzene		1,2-DCA		Vinyl Chloride	
	Model	Field	Model	Field	Model	Field	Model	Field	Model	Field
FLTG-14	0.00	1.40	0.82	34.10	0.00	0.00	0.00	0.00	0.00	0.00
S1-106A*		29.00		2.50		0.00		0.00		0.00
S1-106R	0.00	0.90	6.77	18.80	14.79	25.00	1.51	0.00	0.00	0.00
S1-118	2.57	1.20	0.00	5.70	0.00	0.00	0.00	0.00	0.00	0.00
S1-121	0.00	16.00	1.29	5.10	2.06	0.00	90.79	3.00	7.70	0.00
S1-123	0.33	1.20	1.80	6.80	0.78	0.00	88.77	0.00	1.15	21.00
S1-131	0.00	1.80	8.53	42.70	4.60	32.00	1.90	0.00	0.00	0.00

Explanation

< less than
DO+ combined term for dissolved oxygen and nitrate, expressed as equivalent DO (mg/L)
TOC total organic carbon (mg/L)
Benzene, 1,2-DCA, and vinyl chloride data are in µg/L

* No model data is available for S1-106A because it was not set as an output point during the one-year run.

Progress monitoring wells available for comparison in each area are as follows:

Area	Wells
INT west	INT-22, INT-101, INT-134, INT-135, INT-214, INT-217, INT-233
INT central	INT-26, INT-60-P3, INT-108, INT-120
INT-11 wall	INT-106, INT-120, INT-123, INT-127
S1 east	FLTG-14, S1-106A, S1-106R, S1-118, S1-121, S1-123, S1-131

3.3.5.1 Model vs field results - INT west area

Modeled and field DO are both generally low. The main exception is that the model predicts high DO at INT-135, whereas high DO was observed at INT-134. Modeled and field TOC are generally similar, except at INT-134, INT-135, and INT-217, where field TOC is significantly higher, and at INT-233, where field TOC is lower. Benzene is generally higher in the model than in the field, except at INT-134 and INT-217. 1,2-DCA is generally higher in the model than in the field, except at INT-134. Vinyl chloride is generally higher in the model than in the field, except at INT-134. Benzene, 1,2-DCA, and vinyl chloride at INT-233 are all notably higher in the model than in the field.

Higher concentrations of TOC, benzene, 1,2-DCA, and vinyl chloride in the model compared with the field are generally not an immediate concern, as they indicate that the model is conservative with respect to reality. The higher field concentrations of TOC in the southwest INT area are of some concern as the model is sensitive to TOC, and higher TOC in this area may retard natural attenuation more than predicted. The lower model concentrations at INT-134 are because sample data was not available from INT-134 for the 1995 model, whereas field results were available in 1996. The difference between model and field at INT-233 is probably because this is a former "hot spot" in which concentrations are very variable.

3.3.5.2 Model vs field results - INT central area

Model and field DO are similar for INT-108 and INT-120, but are very different for INT-26 and INT-60-P3. Model DO is significantly higher at INT-26, and significantly lower at INT-60-P3. Model and field TOC are generally similar, except at INT-26; field TOC is higher. Model and field benzene are similar for INT-108 and INT-120, but are very different for INT-26 and INT-60-P3. Model and field 1,2-DCA and vinyl chloride are very low, with model and field in good agreement.

3.3.5.3 Model vs field results - INT-11 wall area

Model and field DO, TOC, benzene, and vinyl chloride are generally similar for all wells. Field TOC and benzene are higher than modeled values. Model and field 1,2-DCA agree poorly, especially for INT-123. This is probably because this is a former 1,2-DCA "hot spot" in which concentrations are very variable.

3.3.5.4 Model vs field results - S1 east area

Modeled and field DO are both generally low. The main exception is that the model predicts low DO at S1-121, whereas field DO was high. Modeled and field TOC are generally similar, except at FLTG-14, S1-106R, and S1-131, where field TOC is significantly higher. Benzene is generally similar, except at S1-131, where field benzene is higher. 1,2-DCA is generally similar, except at S1-121 and S1-123, where the model value is significantly higher. Vinyl chloride is generally similar, except at S1-123, where the model value is significantly higher.

3.3.5.5 Model vs field results - general

In general, model results agree fairly well, with a few exceptions. Further data is required to justify

3.3.6 Model predictions for 2005

The following summaries describe conditions predicted by the 1996 model for the year 2005.

3.3.6.1 Model predictions - INT west area

By 2005, electron acceptors (DO+) are completely consumed in most of the area north of Gulf Pump Road, and in three areas south of Gulf Pump Road:

1. immediately south of road - INT-22 to INT-24
2. southwest - INT-134 and INT-135
3. south - INT-217

These three areas generally coincide with areas of persistent TOC. Benzene and vinyl chloride are present above MCL in the same three areas. 1,2-DCA is present above MCL only in the southwest area.

3.3.5.2 Model predictions - INT central area

By 2005, electron acceptors (DO+) are completely consumed in most of the area north of Gulf Pump Road, and in two areas south of Gulf Pump Road.

1. immediately south of road - INT-110 to INT-108
2. southeast - INT-119

These two areas generally coincide with areas of persistent TOC. Benzene is present above MCL in the area south of the road. 1,2-DCA and vinyl chloride are present above MCL only in one small area north of the road. There are no chemicals above MCL in the southeast area.

3.3.5.3 Model predictions - INT-11 wall area

By 2005, electron acceptors (DO+) are completely consumed in four areas.

1. north of road, west - INT-10
2. north of road, east - INT-12
3. immediately south/southwest of wall - INT-127 and INT-228/230
4. south of road - INT-106

These four areas generally coincide with areas of persistent TOC. Benzene is present above MCL in the west and south/southwest areas. 1,2-DCA is present above MCL in the west, east, and south/southwest areas. Vinyl chloride is present above MCL in the west and east areas.

3.3.5.4 Model predictions - S1 east area

By 2005, electron acceptors (DO+) are completely consumed over most of the model area. This area generally coincides with an area of persistent TOC. Benzene is present above MCL in the area around FLTG-8 and S1-106. 1,2-DCA is present above MCL only in one small area north of the road. Vinyl chloride is below MCL over the entire model area.

3.3.5.5 Model predictions - summary

The model predicts that benzene, 1,2-DCA, and vinyl chloride above MCL will exist in some areas south of Gulf Pump Road, predominantly in the INT unit. This prediction is strongly weighted by the higher TOC readings that were obtained during the October 1996 groundwater sampling event, and which were used to create the "hybrid" starting conditions for the main nine-year model run.

SECTION 4.0

4.0 Passive natural attenuation enhancement

4.1 Design basis

The results of the modeling described in Section 3.0 indicate that there are several areas in the INT Zone where rates of natural attenuation may need to be enhanced in order for target compounds to meet clean-up criteria at points of compliance within the appropriate time frame. These areas are:

1. Southwest - from INT-134/135 to INT-233
2. South - at INT-217
3. Central - at INT-26
4. East - defined by wells INT-127, INT-106, and INT-130R/RS

Elevated concentrations of TOC in these four areas appears to be the major influence on natural attenuation rates, as biodegradation of TOC consumes oxygen and other electron acceptors that are not then available for biodegradation of target chemicals.

Enhancement of natural attenuation can be achieved using a passive approach to increase the supply of electron acceptors in these areas. The method that will be used is to introduce oxygen and nutrient release compounds, in a slurry form, into a network of boreholes in the affected areas. These compounds will provide a passive source of oxygen and nutrients to the groundwater for an extended period of time (up to six months).

The solid oxygen release compound (ORC) will be either calcium peroxide or magnesium peroxide. Both compounds are available in a powder form and can be introduced as a slurry into a borehole. The compounds will release oxygen in a molecular form when contacted with water. Nutrient release compounds will probably be a diammonium phosphate (DAP) and/or ammonium nitrate. These compounds will provide a long-term source of nitrogen and phosphorous nutrients and also nitrate that can be used as an electron acceptor.

The boreholes will be drilled to the base of the INT unit and backfilled with the release compounds within the INT interval. The remainder of the borehole will then be backfilled with bentonite. Details of the method are described below. The flow of groundwater through the backfilled borehole will slowly dissolve the nutrient compounds and cause oxygen to be released from the peroxide compounds.

The oxygen demand in any one area is roughly proportional to the mass of biodegradable organic contaminants in the soils and groundwater of the area. Typically, the rate of natural bioremediation is controlled by the rate of introduction of an electron acceptor, in this case, a combination of nitrate and oxygen. Therefore, the number of boreholes in each area is largely a function of the mass of biodegradable compounds present, and the rate of natural groundwater flow through each area.

4.2 Oxygen Release Compound

The oxygen release compound (ORC) will be either calcium peroxide or magnesium peroxide. Both compounds are manufactured as a mixture of the peroxide and the hydroxide, typically in a 60:40 ratio by weight. The oxygen release by weight from the ORC is about 10%. The compounds are manufactured in a powder form (minus 325 mesh) and may be delivered in bulk (5 gal [30 lb.] buckets or 100 lb. drums) or in pre-packaged "socks".

For this project, the material will be mixed with water into a 66% slurry and introduced into the boreholes in this form. The compounds will release oxygen in a molecular form when contacted with water. Thus they will provide a source of oxygen to groundwater for an extended period of time depending on the pH and flow rate of groundwater through the infilled borehole. The oxygen release period for these ORCs are reported to be up to six months.

4.3 Drilling Plan

Boreholes will be drilled in each area using a standard hollow-stem auger drilling rig. Each borehole will be drilled to the base of the INT unit (approximately 55 feet below grade) with 10.75-inch OD hollow-stem augers. Cuttings will be drummed for proper disposal. Upon reaching the total depth of the borehole, the lead auger will be removed and a tremie pipe run to the bottom of the hole through the hollow stem augers. The slurry mixture of ORC and nutrients will be introduced through this pipe in batches of about 20 gallons as the augers are gradually withdrawn from the borehole. When the calculated volume of ORC slurry has been introduced to fill the borehole to the top of the INT unit, the remainder of the borehole will be filled with a bentonite slurry mix.

The thickness of the INT unit is typically from 20 to 25 feet. Each 10.75-inch diameter borehole will have a volume of ORC/nutrient slurry of about 16 cubic feet or 120 gallons. The weight of ORC in the slurry is about 30 lb/ft^3 (66% slurry with powder density of approximately 44 lb/ft^3). The oxygen release by weight from the ORC is about 10% so that the total oxygen mass release from each borehole will be between 38 to 47 lbs. This will have the capability of biodegrading between 12 to 16 lbs. of hydrocarbons, assuming an average 3:1 stochiometric relationship.

4.3.1 *Southwest area*

This area is defined by wells INT-134/135 to the south west and by well INT-233 to the northeast. A total of 20 boreholes will be drilled approximately 20 feet apart along two lines in the vicinity of well INT-233. One line will follow the contour of the former steel sheetpile wall, but approximately 20 feet to the south of the wall. The second line will be approximately 50 feet north of Gulf Pump Road.

4.3.2 South area

This area is in the vicinity of well INT-217. A total of 10 boreholes will be drilled approximately 20 feet apart along two east-west parallel lines, 20 feet apart north and south of well INT-217.

4.3.3 Central area

This area is in the vicinity of well INT-26. A total of 10 boreholes will be drilled approximately 20 feet apart along two east-west parallel lines, 20 feet apart north and south of well INT-26.

4.3.4 East area

This area is defined by wells INT-127, INT-106, and INT-130R/RS. A total of 15 boreholes will be drilled in this area. Five boreholes will be drilled approximately 20 feet apart along an east-west line centered on and 10 feet north of well INT-130R/RS. A similar arrangement of five boreholes will be drilled north of well INT 106. A third series of five boreholes will be drilled between INT-127 and the old sheet-pile wall. The wall will limit the distance to the north of the well that the boreholes can be drilled.

SECTION 5.0

5.0 Conclusions/action plan

The analytical results indicate that the affected S1 and INT groundwater does not represent a threat to the public health or the environment: FLTG continues to control all property that currently contains affected groundwater.

S1-123 showed a sharp decrease in 1,2-DCA and vinyl chloride, which was confirmed by triplicate samples.

The French site Record of Decision (ROD), the Consent Decree, and the Remedial Action Plan (RAP) describe a two-phase aquifer remediation process:

Phase 1 - active remediation
Phase 2 - natural attenuation

The site should continue in phase 2, with enhanced natural attenuation based on passive delivery of additional electron acceptors in areas of low DO, high TOC, and affected groundwater. Therefore, the work plan to design and implement electron acceptor dosing, presented in Section 4.0, should be performed.

It is recommended that the natural attenuation progress evaluation continue as per Chapter 12 of the *Site closure plan.*

APPENDIX A

APPENDIX A

October 1996 groundwater sampling results

R. Jansen Associates

Memo

RECEIVED NOV 20 1996

To: Dick Sloan

From: Ron Jansen

CC: Jim Thomson, Mark Collins

Date: November 14, 1996

Re: French Ltd. Groundwater Monitoring - October, 1996 Event

Attached are the analytical result summaries for the October, 1996 groundwater monitoring event at the French Ltd. Project. These samples were collected on October 7th and 8th, 1996. There are two sections of data as follows:

- Attachment A - Analytical Result Summaries with Historical Data
- Attachment B - Field Duplicate Precision Summaries

Analytical QC Summary

All analytical was validated manually for these samples. The data was validated per Level 1 data validation protocols. Level 1 data validation protocols are specified for groundwater progress monitoring samples. All analytical data with the exception of those listed in Table 1 met QC requirements.

On previous historical summaries, the detection limit reported was lower than is being reported in this summary for this sampling event. The detection limits reported for this sampling event are expressed as the method specified detection limit. The detection limits shown for previous sampling events are expressed as the instrument detection limit (IDL). The IDL changes slightly over time at each lab and for each different instrument. Although the lab can detect compounds of interest at a level lower than the method detection limit (MDL), the MDL is the concentration that they can quantify with certainty. If the lab reported a value below the MDL (commonly referred to as a "J" value), they reported that concentration and I included it in the historical summary for this and all other sampling events. I recommend that we continue to use the MDL as the reportable concentration until we get closer to the clean-up compliance sampling event. The compliance sampling event will require that we use a different analytical method to achieve lower detection limits.

There were no trip Blanks or field blanks submitted with these samples.

There were four (4) field duplicates submitted with these samples. These were not blind field duplicates. The samples were submitted with the suffix "D" after the well name to indicate a field duplicate(i.e. INT-127 and INT-127D). Field duplicates measure both sampling and analytical precision. The duplicate samples were collected immediately after the original sample at each well. The relative percent difference (RPD) results indicate that the analytical and sampling procedures are readily repeatable. A RPD value of 20% or less is acceptable. There were a few instances where the RPD was higher than 20%. In these cases, the concentrations of detected analyte were near or below the detection limit. Analytical results tend to get variable near the detection limit. One of the four field duplicates had no detectable concentrations of compounds of interest (S1-051-P-3).

Table 1

Well Number	Analysis	QC Failure	Comments
INT-144	Volatile (8240)	Internal standard 1 area was outside QC limits (low).	Sample was reanalyzed within holding times and all internal standards were within QC limits. No corrective action required.

ATTACHMENT A

Analytical Results with Historical Data

French Limited Project

FLTG-013

Compound	Criteria	Units	12 - 94	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	2.6	1.8	1.8	0.1	1.0
pH		pH un	7.8	7.4	7.4	7.0	6.9
Specific Conductivity		umhos	800.0	300.0	350.0	345.0	600.0
Temperature		deg C	21.0	21.0	21.0	22.0	23.0
Total Organic Carbon		ppm	8.1	< 5.0	4.4	< 1.0	3.4
Ammonia-N		mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Nitrate-N		mg/L	< 2.0	0.4	< 0.2	< 0.1	< 0.2
Orthophosphate-P		mg/L	< 2.0	< 0.1	< 0.1	0.1	< 0.1
Potassium		mg/L	0.9	1.1	1.1	1.1	1.1
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	< 0.8	< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.3	< 0.3	< 0.3	< 0.3	< 5.0
Toluene	1000	ug/L	< 0.5	< 0.5	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L	< 1.2	< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

FLTG-014

Compound	Criteria	Units	12 - 94	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	2.4	1.4	1.7	0.1	1.4
Field pH		pH un	7.8	7.2	7.0	7.0	6.6
Specific Conductivity		umhos	1000.0	220.0	300.0	390.0	1100.0
Temperature		deg C	21.0	19.0	22.0	22.0	24.0
Total Organic Carbon		ppm	8.2	< 3.0	5.9	< 1.0	5.6
Ammonia-N		mg/L	< 0.1	0.5	0.7	0.9	0.6
Nitrate-N		mg/L	< 2.0	< 0.2	< 0.2	< 0.1	< 0.2
Orthophosphate-P		mg/L	< 2.0	< 0.1	< 0.1	0.4	< 0.1
Potassium		mg/L	1.8	1.3	1.6	1.8	1.8
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	< 0.8	< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.3	< 0.3	7.0	< 0.3	< 5.0
Toluene	1000	ug/L	< 0.5	< 0.5	3.0	< 0.5	< 5.0
Vinyl chloride	2	ug/L	< 1.2	< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-022

Compound	Criteria	Units	10 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	4.2	1.8	1.6	0.2	0.8
pH		pH un	7.1	6.9	6.9	7.2	7.0
Specific Conductivity		umhos	850.0	550.0	600.0	650.0	875.0
Temperature		deg C	24.0	23.0	21.0	22.0	23.0
Total Organic Carbon		ppm	25.0	< 0.4	4.2	< 1.0	4.1
Ammonia-N		mg/L	0.8	0.8	0.4	0.1	0.3
Nitrate-N		mg/L	16.7	2.0	0.2	0.1	< 0.2
Orthophosphate-P		mg/L	< 0.2	2.6	< 0.1	0.1	< 0.1
Potassium		mg/L	83.8	31.7	33.1	39.0	28.8
Arsenic	50	ug/L		21.0			
Chromium	100	ug/L		< 10.0			
Lead	15	ug/L		< 5.0			
1,2-Dichloroethane	5	ug/L	9.0	< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	9.0	44.0	< 0.3	< 0.3	4.0
Toluene	1000	ug/L	< 0.5	3.0	< 0.5	< 0.5	3.0
Vinyl chloride	2	ug/L	19.0	26.0	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-026

Compound	Criteria	Units	04 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm		2.5	1.2	0.1	0.7
Field pH		pH un		6.4	7.0	7.0	7.0
Specific Conductivity		umhos		800.0	550.0	900.0	1000.0
Temperature		deg C		22.0	21.0	24.0	23.5
Total Organic Carbon		ppm	107.0	< 3.0	47.3	27.6	34.1
Ammonia-N		mg/L		1.2	1.6	2.0	1.5
Nitrate-N		mg/L		4.0	< 0.2	< 0.1	< 0.2
Orthophosphate-P		mg/L		586.0	37.4	35.0	36.3
Potassium		mg/L		926.0	82.4	78.0	43.7
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L		< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L		< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L		180.0	98.0	100.0	75.0
Toluene	1000	ug/L		7.0	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L		< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-059-P-2

Compound	Criteria	Units	12 - 94	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm		0.7	1.3	6.6	0.8
pH		pH un		7.0	7.0	6.9	6.7
Specific Conductivity		umhos		230.0	300.0	390.0	975.0
Temperature		deg C		23.0	21.0	24.0	25.0
Total Organic Carbon		ppm	18.4	< 5.0			
Ammonia-N		mg/L	0.4				
Nitrate-N		mg/L	< 2.0				
Orthophosphate-P		mg/L	2.6				
Potassium		mg/L				2.6	
Arsenic	50	ug/L	47.3	68.0	50.0	32.0	41.0
Chromium	100	ug/L	< 0.7	< 10.0	< 10.0	< 10.0	< 10.0
Lead	15	ug/L		< 5.0	< 5.0	< 3.0	< 5.0
1,2-Dichloroethane	5	ug/L	< 0.8				
Acetone	3500	ug/L	< 6.0				
Benzene	5	ug/L	21.0				
Toluene	1000	ug/L	< 0.5				
Vinyl chloride	2	ug/L	< 1.2				

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-060-P-3

Compound	Criteria	Units	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	15.0	15.0	15.0	13.0
pH		pH un	6.8	7.0	7.1	7.1
Specific Conductivity		umhos	500.0	850.0	1380.0	1425.0
Temperature		deg C	22.0	21.0	24.0	24.5
Total Organic Carbon		ppm	< 3.0	2.2	< 1.0	1.4
Ammonia-N		mg/L	< 0.1	0.1	< 0.1	< 0.1
Nitrate-N		mg/L	41.6	112.0	100.0	91.0
Orthophosphate-P		mg/L	0.2	< 0.1	0.1	< 0.1
Potassium		mg/L	37.9	118.0	120.0	124.0
Arsenic	50	ug/L				
Chromium	100	ug/L				
Lead	15	ug/L				
1,2-Dichloroethane	5	ug/L	< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.3	25.0	< 0.3	< 5.0
Toluene	1000	ug/L	< 0.5	11.0	< 0.5	< 5.0
Vinyl chloride	2	ug/L	< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-101

Compound	Criteria	Units		12 - 95		01 - 96		04 - 96		07 - 96		10 - 96
Dissolved Oxygen		ppm		0.5		1.0		1.4		0.0		0.9
pH		pH un		6.9		7.0		6.8		6.8		7.0
Specific Conductivity		umhos		500.0		500.0		470.0		600.0		650.0
Temperature		deg C		23.0		23.0		21.0		22.0		23.0
Total Organic Carbon		ppm		84.0	<	3.0		29.4		8.8		12.5
Ammonia-N		mg/L	<	0.1	<	0.1	<	0.1	<	0.1	<	0.1
Nitrate-N		mg/L	<	0.2	<	0.2	<	0.2	<	0.1	<	0.2
Orthophosphate-P		mg/L	<	0.1	<	0.1		0.5		0.6		0.2
Potassium		mg/L		1.4		0.7		0.7		0.6		0.6
Arsenic	50	ug/L		115.0		96.0		60.0		60.0		65.0
Chromium	100	ug/L	<	10.0	<	10.0	<	10.0	<	10.0	<	10.0
Lead	15	ug/L	<	5.0	<	5.0	<	5.0	<	3.0	<	5.0
1,2-Dichloroethane	5	ug/L	<	2.6	<	0.8	<	0.8	<	0.8	<	5.0
Acetone	3500	ug/L	<	19.8	<	6.0	<	6.0	<	6.0	<	10.0
Benzene	5	ug/L		218.0		120.0		36.0		36.0		33.0
Toluene	1000	ug/L	<	1.7	<	0.5	<	0.5	<	0.5	<	5.0
Vinyl chloride	2	ug/L	<	4.0	<	1.2	<	1.2	<	1.2	<	10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

French Limited Project

INT-106

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	0.4	0.4	1.4	0.1	0.6
pH		pH un	7.0	6.9	7.1	7.2	7.4
Specific Conductivity		umhos	550.0	550.0	600.0	900.0	1050.0
Temperature		deg C	23.0	23.0	21.0	22.0	24.0
Total Organic Carbon		ppm	30.0	< 1.2	22.2	10.7	23.6
Ammonia-N		mg/L	< 0.1	< 0.1	< 0.1	0.1	0.1
Nitrate-N		mg/L	13.4	3.0	< 0.2	< 0.1	< 0.2
Orthophosphate-P		mg/L	< 0.1	< 0.1	< 0.1	0.1	< 0.1
Potassium		mg/L	3.1	2.7	2.5	2.4	1.7
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	43.0	22.0	63.0	54.0	30.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.3	< 0.3	6.0	4.0	10.0
Toluene	1000	ug/L	< 0.5	< 0.5	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L	9.0	< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-108

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	3.8	0.6	1.5	0.1	0.7
pH		pH un	6.8	6.8	7.2	7.0	6.7
Specific Conductivity		umhos	410.0	390.0	450.0	750.0	800.0
Temperature		deg C	23.0	23.0	21.0	26.0	24.5
Total Organic Carbon		ppm	7.0	< 0.4	5.5	< 1.0	4.8
Ammonia-N		mg/L	1.0	0.2	< 0.1	0.4	0.6
Nitrate-N		mg/L	< 0.2	4.0	1.2	< 0.1	< 0.2
Orthophosphate-P		mg/L	0.3	0.8	0.9	1.1	1.9
Potassium		mg/L	9.8	41.4	39.3	43.0	35.4
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	< 0.8	< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.3	< 0.3	< 0.3	< 0.3	< 5.0
Toluene	1000	ug/L	< 0.5	< 0.5	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L	< 1.2	< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-118

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	1.3	1.1	4.6	5.4	1.2
pH		pH un	8.2	8.3	8.6	9.8	8.6
Specific Conductivity		umhos	210.0	245.0	400.0	300.0	400.0
Temperature		deg C	24.0	24.0	22.0	24.0	25.0
Total Organic Carbon		ppm	2.4	< 5.0	< 2.0	< 1.0	1.4
Ammonia-N		mg/L		< 0.1	< 0.1	< 0.1	< 0.1
Nitrate-N		mg/L		0.2	371.0	0.4	< 0.2
Orthophosphate-P		mg/L		< 0.1	< 0.1	0.0	< 0.1
Potassium		mg/L		1.2	3.5	4.3	1.5
Arsenic	50	ug/L		< 10.0	< 10.0	< 10.0	< 10.0
Chromium	100	ug/L		< 10.0	< 10.0	< 10.0	< 10.0
Lead	15	ug/L		< 5.0	< 5.0	< 3.0	< 5.0
1,2-Dichloroethane	5	ug/L	< 0.8	< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.3	< 0.3	< 0.3	< 0.3	< 5.0
Toluene	1000	ug/L	< 0.5	< 0.5	< 0.5	2.0	< 5.0
Vinyl chloride	2	ug/L	< 1.2	< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument

< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-120

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	3.8	15.0	1.6	0.1	1.1
pH		pH un	7.3	7.2	7.1	7.9	7.5
Specific Conductivity		umhos	1300.0	900.0	750.0	1350.0	1350.0
Temperature		deg C	23.0	24.0	22.0	23.0	25.0
Total Organic Carbon		ppm	18.0	< 150.0	4.4	< 1.0	2.6
Ammonia-N		mg/L	< 0.1	0.9	0.9	0.3	0.4
Nitrate-N		mg/L	329.0	36.1	23.3	66.0	21.1
Orthophosphate-P		mg/L	37.4	470.0	21.6	10.0	4.1
Potassium		mg/L	94.1	834.0	122.0	130.0	107.0
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	1400.0	8400.0	21.0	87.0	34.0
Acetone	3500	ug/L	< 120.0	< 300.0	< 15.0	< 6.0	< 10.0
Benzene	5	ug/L	< 6.0	< 15.0	5.0	3.0	5.0
Toluene	1000	ug/L	< 10.0	< 25.0	< 1.3	< 0.5	< 5.0
Vinyl chloride	2	ug/L	< 24.0	260.0	< 3.0	10.0	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-123

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	15.0	15.0	6.4	0.8	2.0
pH		pH un	7.2	8.6	8.2	9.7	9.6
Specific Conductivity		umhos	495.0	500.0	500.0	800.0	900.0
Temperature		deg C	23.0	24.0	22.0	23.0	25.0
Total Organic Carbon		ppm	8.0	< 3.0	4.2	< 1.0	4.2
Ammonia-N		mg/L	< 0.1	< 0.1	< 0.1	< 0.1	0.1
Nitrate-N		mg/L	119.0	25.6	23.2	21.0	20.1
Orthophosphate-P		mg/L	4.1	0.7	0.4	0.3	0.2
Potassium		mg/L	68.4	73.6	58.9	62.0	53.3
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	580.0	120.0	210.0	270.0	300.0
Acetone	3500	ug/L	< 30.0	20.0	< 12.0	< 6.0	< 10.0
Benzene	5	ug/L	< 1.5	< 0.3	< 0.6	2.0	5.0
Toluene	1000	ug/L	< 2.5	< 0.5	< 1.0	< 0.5	< 5.0
Vinyl chloride	2	ug/L	77.0	15.0	< 2.4	3.0	< 10.0

\+ = Compound concentration more than linear calibration range of instrument

< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-127

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	1.7	2.0	0.8	0.1	0.7
Field pH		pH un	6.8	6.3	6.7	6.7	6.3
Specific Conductivity		umhos	700.0	750.0	850.0	1650.0	1750.0
Temperature		deg C	23.0	24.0	22.0	23.0	26.0
Total Organic Carbon		ppm	90.0	77.7	70.0	44.0	78.3
Ammonia-N		mg/L	0.1	0.1	0.7	0.9	0.6
Nitrate-N		mg/L	24.1	4.0	47.9	< 0.1	< 0.2
Orthophosphate-P		mg/L	0.2	< 0.1	< 0.1	0.0	< 0.1
Potassium		mg/L	11.1	6.0	10.9	14.0	9.2
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	< 0.8	< 0.8	< 0.8	< 8.0	< 5.0
Acetone	3500	ug/L	84.0	120.0	< 6.0	< 60.0	< 10.0
Benzene	5	ug/L	140.0	150.0	160.0	170.0	200.0
Toluene	1000	ug/L	36.0	37.0	34.0	43.0	50.0
Vinyl chloride	2	ug/L	< 1.2	< 1.2	< 1.2	< 12.0	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-130R

Compound	Criteria	Units	04 - 96	07 - 96	10 - 96		
Dissolved Oxygen		ppm	1.7	1.4	2.1		
pH		pH un	7.4	7.5	7.2		
Specific Conductivity		umhos	850.0	900.0	925.0		
Temperature		deg C	26.0	23.0	25.0		
Total Organic Carbon		ppm	12.7	2.9	11.9		
Ammonia-N		mg/L	< 0.1	0.2	0.2		
Nitrate-N		mg/L	30.6	32.0	32.0		
Orthophosphate-P		mg/L	< 0.1	0.1	< 0.1		
Potassium		mg/L	1.5	2.4	1.6		
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	500.0	450.0	450.0		
Acetone	3500	ug/L	< 1000.0	< 6.0	< 1000.0		
Benzene	5	ug/L	< 500.0	27.0	< 500.0		
Toluene	1000	ug/L	< 500.0	5.0	< 500.0		
Vinyl chloride	2	ug/L	< 1000.0	< 1.2	< 1000.0		

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-130RS

Compound	Criteria	Units	04 - 96	07 - 96	10 - 96		
Dissolved Oxygen		ppm	2.1	0.1	0.6		
pH		pH un	7.2	7.2	6.9		
Specific Conductivity		umhos	900.0	1050.0	1100.0		
Temperature		deg C	25.0	23.0	26.0		
Total Organic Carbon		ppm	17.4	10.0	15.9		
Ammonia-N		mg/L	< 0.1	< 0.1	0.1		
Nitrate-N		mg/L	23.2	20.0	17.5		
Orthophosphate-P		mg/L	< 0.1	0.1	< 0.1		
Potassium		mg/L	1.8	3.3	1.9		
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	1800.0	290.0	100.0		
Acetone	3500	ug/L	< 200.0	< 6.0	< 250.0		
Benzene	5	ug/L	< 100.0	21.0	< 120.0		
Toluene	1000	ug/L	< 100.0	< 0.5	< 120.0		
Vinyl chloride	2	ug/L	180.0	250.0	180.0		

* = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-134

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	14.6	0.7	1.2	0.1	1.2
pH		pH un	6.8	7.4	7.4	7.4	7.5
Specific Conductivity		umhos	370.0	500.0	525.0	1000.0	1000.0
Temperature		deg C	24.0	22.0	22.0	22.0	23.0
Total Organic Carbon		ppm	8.0	< 1.0	21.6	15.0	34.1
Ammonia-N		mg/L	< 0.1	0.3	0.7	0.5	0.6
Nitrate-N		mg/L	21.3	1.8	0.5	0.8	2.0
Orthophosphate-P		mg/L	0.2	18.0	8.7	4.0	1.2
Potassium		mg/L	1.4	43.1	26.4	16.0	7.2
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	78.0	68.0	67.0	85.0	110.0
Acetone	3500	ug/L	< 15.0	< 12.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	26.0	34.0	27.0	54.0	56.0
Toluene	1000	ug/L	< 1.3	< 1.0	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L	198.0	190.0	19.0	140.0	190.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-135

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	3.8	1.0	1.0	0.2	0.8
pH		pH un	7.0	7.0	6.9	6.8	6.8
Specific Conductivity		umhos	325.0	440.0	500.0	820.0	800.0
Temperature		deg C	23.0	23.0	23.0	22.0	24.0
Total Organic Carbon		ppm	10.0	< 3.0	14.3	8.1	11.8
Ammonia-N		mg/L	< 0.1	< 0.1	0.1	0.1	< 0.1
Nitrate-N		mg/L	0.5	2.2	< 0.2	< 0.1	< 0.2
Orthophosphate-P		mg/L	< 0.1	< 1.0	< 0.1	0.0	< 0.1
Potassium		mg/L	1.2	1.2	1.2	1.2	1.1
Arsenic	50	ug/L		< 10.0	20.0	22.0	23.0
Chromium	100	ug/L		< 10.0	< 10.0	< 10.0	< 10.0
Lead	15	ug/L		< 5.0	< 5.0	< 3.0	< 5.0
1,2-Dichloroethane	5	ug/L	29.0	15.0	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 12.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.6	< 0.3	< 0.3	< 0.3	< 5.0
Toluene	1000	ug/L	< 1.0	< 0.5	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L	146.0	66.0	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument

French Limited Project

INT-144

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	0.7	0.7	2.4	1.8	2.4
pH		pH un	8.8	8.6	8.8	9.7	9.1
Specific Conductivity		umhos	300.0	310.0	325.0	370.0	925.0
Temperature		deg C	21.0	23.0	21.0	21.0	23.5
Total Organic Carbon		ppm	1.5	< 3.0	< 2.0	< 1.0	< 1.0
Ammonia-N		mg/L	< 0.1	0.2	< 0.1	< 0.1	< 0.1
Nitrate-N		mg/L	< 0.2	< 0.2	< 0.2	0.1	< 0.2
Orthophosphate-P		mg/L	0.2	< 0.1	< 0.1	0.1	< 0.1
Potassium		mg/L	1.2	0.9	1.0	1.0	0.9
Arsenic	50	ug/L		< 10.0	20.0	17.0	17.0
Chromium	100	ug/L		< 10.0	< 10.0	< 10.0	< 10.0
Lead	15	ug/L		< 5.0	< 5.0	< 3.0	< 5.0
1,2-Dichloroethane	5	ug/L	< 0.8	< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.3	< 0.3	< 0.3	< 0.3	< 5.0
Toluene	1000	ug/L	< 0.5	< 0.5	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L	3.0	< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument

French Limited Project

INT-214

Compound	Criteria	Units	02 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm		1.0	1.4	0.1	0.7
pH		pH un		6.9	7.5	7.2	6.7
Specific Conductivity		umhos		700.0	575.0	750.0	800.0
Temperature		deg C		23.0	21.0	22.0	23.5
Total Organic Carbon		ppm		< 0.7	3.0	< 1.0	2.5
Ammonia-N		mg/L		0.2	< 0.1	< 0.1	0.2
Nitrate-N		mg/L		5.5	1.5	< 0.1	< 0.2
Orthophosphate-P		mg/L		60.6	6.0	1.7	1.1
Potassium		mg/L		188.0	88.9	70.0	60.5
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	7.0	< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	19.0	< 0.3	< 0.3	< 0.3	< 5.0
Toluene	1000	ug/L	< 0.5	< 0.5	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L	61.0	< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-217

Compound	Criteria	Units	11 - 95		01 - 96		04 - 96		07 - 96		10 - 96
Dissolved Oxygen		ppm		0.4		0.4		0.9		0.1		1.0
pH		pH un		6.5		6.9		6.7		6.7		6.3
Specific Conductivity		umhos		750.0		1000.0		805.0		1300.0		1200.0
Temperature		deg C		23.0		23.0		21.0		22.0		23.0
Total Organic Carbon		ppm		74.0	<	2.5		56.8		48.4		53.8
Ammonia-N		mg/L	<	0.1		1.1		0.4		0.1		0.1
Nitrate-N		mg/L		0.8		0.5	<	0.2	<	0.1	<	0.2
Orthophosphate-P		mg/L	<	0.2		206.0		5.9		1.0		0.4
Potassium		mg/L		1.3		385.0		19.6		2.1		1.4
Arsenic	50	ug/L										
Chromium	100	ug/L										
Lead	15	ug/L										
1,2-Dichloroethane	5	ug/L	<	0.8	<	0.8	<	0.8	<	0.8	<	5.0
Acetone	3500	ug/L	<	6.0	<	6.0	<	6.0	<	6.0	<	10.0
Benzene	5	ug/L		14.0		22.0		51.0		16.0		22.0
Toluene	1000	ug/L	<	0.5	<	0.5		12.0	<	0.5	<	5.0
Vinyl chloride	2	ug/L		41.0		51.0		8.0		9.0		17.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

INT-233

Compound	Criteria	Units		11 - 95		01 - 96		04 - 96		07 - 96		10 - 96
Dissolved Oxygen		ppm		0.3				0.7		0.1		0.7
pH		pH un		6.4		6.8		6.8		6.7		6.7
Specific Conductivity		umhos		4000.0		750.0		1200.0		2050.0		1800.0
Temperature		deg C		21.0		24.0		22.0		22.0		25.0
Total Organic Carbon		ppm		2850.0	<	1800.0		264.0		100.0		98.9
Ammonia-N		mg/L		0.4		2.6		1.2		7.8		8.7
Nitrate-N		mg/L		0.3	<	0.2	<	0.2	<	0.1	<	0.2
Orthophosphate-P		mg/L	<	0.2	<	0.1		5.5		5.5		4.6
Potassium		mg/L		2.8		16.2		10.5		13.0		9.1
Arsenic	50	ug/L										
Chromium	100	ug/L										
Lead	15	ug/L										
1,2-Dichloroethane	5	ug/L	<	80.0	<	160.0	<	2.7	<	8.0	<	16.0
Acetone	3500	ug/L		7600.0		27000.0	<	19.8	<	60.0	<	33.0
Benzene	5	ug/L		1400.0		740.0		370.0		350.0		500.0
Toluene	1000	ug/L	<	50.0	<	100.0		140.0		100.0		19.0
Vinyl chloride	2	ug/L		3000.0	<	240.0	<	4.0	<	12.0	<	33.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

S1-031

Compound	Criteria	Units	08 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	15.0	0.6	1.5	0.0	0.9
pH		pH un	6.9	7.2	7.5	7.4	6.8
Specific Conductivity		umhos	700.0	600.0	300.0	450.0	1050.0
Temperature		deg C	24.0	23.0	21.0	23.0	25.5
Total Organic Carbon		ppm	15.0	< 9.0	4.1	< 1.0	11.4
Ammonia-N		mg/L		0.2	0.6	0.3	0.2
Nitrate-N		mg/L		26.5	2.8	0.2	< 0.2
Orthophosphate-P		mg/L		5.5	1.7	0.5	0.2
Potassium		mg/L		144.0	93.8	32.0	10.9
Arsenic	50	ug/L		< 10.0	< 10.0	< 10.0	< 10.0
Chromium	100	ug/L		13.0	< 10.0	< 10.0	< 10.0
Lead	15	ug/L		5.0	< 5.0	< 3.0	< 5.0
1,2-Dichloroethane	5	ug/L		< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L		< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L		< 0.3	< 0.3	< 0.3	< 5.0
Toluene	1000	ug/L		< 0.5	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L		< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

S1-033

Compound	Criteria	Units	03 - 94	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm		0.4	1.6	0.2	1.2
pH		pH un		6.5	7.2	6.7	6.6
Specific Conductivity		umhos		495.0	450.0	700.0	1150.0
Temperature		deg C		23.0	20.0	22.0	24.0
Total Organic Carbon		ppm		< 3.0	3.5	< 1.0	7.6
Ammonia-N		mg/L		< 0.1	< 0.1	< 0.1	0.2
Nitrate-N		mg/L		131.0	288.0	0.8	< 0.2
Orthophosphate-P		mg/L		1.2	0.6	0.5	0.4
Potassium		mg/L		68.1	59.5	88.0	65.3
Arsenic	50	ug/L		< 10.0	< 10.0	< 10.0	13.0
Chromium	100	ug/L		< 10.0	< 10.0	< 10.0	< 10.0
Lead	15	ug/L		< 5.0	< 5.0	< 3.0	< 5.0
1,2-Dichloroethane	5	ug/L	< 0.8	< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.3	< 0.3	< 0.3	< 0.3	< 5.0
Toluene	1000	ug/L	< 0.5	< 0.5	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L	< 1.2	< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

S1-051-P-3

Compound	Criteria	Units	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	0.6	1.8	1.7	0.7
pH		pH un	6.9	6.9	6.9	6.6
Specific Conductivity		umhos	500.0	450.0	820.0	900.0
Temperature		deg C	21.0	20.0	23.0	24.0
Total Organic Carbon		ppm	< 3.0	11.3	7.8	14.8
Ammonia-N		mg/L	0.8	0.9	1.0	1.3
Nitrate-N		mg/L	7.4	4.2	3.8	< 0.2
Orthophosphate-P		mg/L	< 0.1	< 0.1	0.1	< 0.1
Potassium		mg/L	37.9	54.8	81.0	72.0
Arsenic	50	ug/L				
Chromium	100	ug/L				
Lead	15	ug/L				
1,2-Dichloroethane	5	ug/L	< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.3	< 0.3	< 0.3	< 5.0
Toluene	1000	ug/L	< 0.5	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L	< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

S1-106A

Compound	Criteria	Units	11 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	15.0	15.0	12.6	7.6	1.0
Field pH		pH un	6.7	6.7	7.5	7.3	7.0
Specific Conductivity		umhos	470.0	450.0	400.0	800.0	850.0
Temperature		deg C	25.0	24.0	21.0	22.0	24.0
Total Organic Carbon		ppm	3.0	< 3.0	< 2.0	< 1.0	2.5
Ammonia-N		mg/L	< 0.1	< 0.1	0.2	< 0.1	< 0.1
Nitrate-N		mg/L	21.7	92.3	16.6	23.3	11.4
Orthophosphate-P		mg/L	< 0.2	0.7	0.6	1.0	0.6
Potassium		mg/L	35.0	47.0	43.1	52.0	29.0
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	< 0.8	< 0.8	< 0.8	7.0	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.3	< 0.3	< 0.3	< 0.3	< 5.0
Toluene	1000	ug/L	< 0.5	< 0.5	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L	< 1.2	< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

S1-106R

Compound	Criteria	Units	07 - 96	10 - 96
Dissolved Oxygen		ppm	0.1	0.9
pH		pH un	6.8	6.6
Specific Conductivity		umhos	1100.0	1025.0
Temperature		deg C	21.0	23.0
Total Organic Carbon		ppm	9.0	18.8
Ammonia-N		mg/L	3.2	3.3
Nitrate-N		mg/L	< 0.1	< 0.2
Orthophosphate-P		mg/L	16.0	8.9
Potassium		mg/L	53.0	54.5
Arsenic	50	ug/L		
Chromium	100	ug/L		
Lead	15	ug/L		
1,2-Dichloroethane	5	ug/L	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 10.0
Benzene	5	ug/L	36.0	25.0
Toluene	1000	ug/L	< 0.5	2.0
Vinyl chloride	2	ug/L	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

S1-108A

Compound	Criteria	Units	11 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	0.5	2.0	1.8	0.1	0.8
Field pH		pH un	6.0	6.1	7.1	6.8	6.4
Specific Conductivity		umhos	425.0	470.0	400.0	650.0	775.0
Temperature		deg C	25.0	22.0	20.0	25.0	25.0
Total Organic Carbon		ppm	8.0	51.6	3.8	1.1	4.5
Ammonia-N		mg/L	0.8	0.2	< 0.1	0.7	0.4
Nitrate-N		mg/L	5.8	51.6	4.2	0.5	0.3
Orthophosphate-P		mg/L	< 0.2	0.3	0.1	0.2	0.1
Potassium		mg/L	17.9	28.2	34.2	38.0	34.7
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	10.0	< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.3	< 0.3	4.0	< 0.3	< 5.0
Toluene	1000	ug/L	< 0.5	< 0.5	3.0	< 0.5	< 5.0
Vinyl chloride	2	ug/L	< 1.2	< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

S1-111

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	15.0	15.0	15.0	15.0	8.9
pH		pH un	7.8	7.7	7.2	7.5	6.8
Specific Conductivity		umhos	525.0	900.0	600.0	1050.0	1050.0
Temperature		deg C	21.0	22.0	21.0	22.0	24.0
Total Organic Carbon		ppm	6.7	9.0			
Ammonia-N		mg/L	< 0.1				
Nitrate-N		mg/L	231.0				
Orthophosphate-P		mg/L	18.5				
Potassium		mg/L	126.0			170.0	
Arsenic	50	ug/L		< 10.0	< 10.0	< 10.0	< 10.0
Chromium	100	ug/L		12.0	< 10.0	< 10.0	< 10.0
Lead	15	ug/L		9.0	< 5.0	< 3.0	< 5.0
1,2-Dichloroethane	5	ug/L	< 0.8				
Acetone	3500	ug/L	< 6.0				
Benzene	5	ug/L	< 0.3				
Toluene	1000	ug/L	< 0.5				
Vinyl chloride	2	ug/L	< 1.2				

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

S1-118

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	2.2	1.6	1.6	0.8	1.2
pH		pH un	8.0	6.7	6.7	6.3	6.4
Specific Conductivity		umhos	470.0	200.0	500.0	310.0	825.0
Temperature		deg C	21.0	24.0	21.0	26.0	27.0
Total Organic Carbon		ppm	9.0	< 0.5	6.2	6.1	5.7
Ammonia-N		mg/L		< 0.1	0.1	0.2	0.3
Nitrate-N		mg/L		< 0.2	< 0.2	< 0.1	< 0.2
Orthophosphate-P		mg/L		< 0.1	< 0.1	0.1	< 0.1
Potassium		mg/L		2.7	1.7	1.5	1.9
Arsenic	50	ug/L		< 10.0	< 10.0	< 10.0	< 10.0
Chromium	100	ug/L		< 10.0	< 10.0	< 10.0	< 10.0
Lead	15	ug/L		< 5.0	< 5.0	< 3.0	< 5.0
1,2-Dichloroethane	5	ug/L	< 0.8	< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.3	< 0.3	< 0.3	< 0.3	< 5.0
Toluene	1000	ug/L	< 0.5	< 0.5	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L	< 1.2	< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument

< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

S1-121

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	4.4	10.2	1.7	0.1	1.0
pH		pH un	6.7	6.8	6.8	6.9	6.9
Specific Conductivity		umhos	700.0	750.0	750.0	1300.0	1300.0
Temperature		deg C	25.0	24.0	23.0	23.0	25.0
Total Organic Carbon		ppm	35.0	108.0	14.6	5.2	5.1
Ammonia-N		mg/L	0.1	0.1	0.7	0.6	< 0.1
Nitrate-N		mg/L	< 0.2	56.2	< 0.2	0.8	6.0
Orthophosphate-P		mg/L	< 0.1	< 0.1	< 0.1	0.0	< 0.1
Potassium		mg/L	4.8	108.0	19.0	43.0	34.6
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	48.0	40.0	24.0	8.0	3.0
Acetone	3500	ug/L	324.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	57.0	< 0.3	5.0	4.0	< 5.0
Toluene	1000	ug/L	24.0	< 0.5	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L	311.0	17.0	66.0	8.0	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

S1-123

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	14.6	3.2	2.2	5.0	1.2
pH		pH un	6.8	7.1	7.0	6.8	6.6
Specific Conductivity		umhos	370.0	500.0	550.0	1130.0	1100.0
Temperature		deg C	24.0	25.0	22.0	24.0	26.0
Total Organic Carbon		ppm	8.0	0.4	4.8	9.3	6.8
Ammonia-N		mg/L	< 0.1	< 0.1	0.3	0.4	0.6
Nitrate-N		mg/L	7.4	2.4	0.2	< 0.1	< 0.2
Orthophosphate-P		mg/L	0.8	0.4	0.3	0.9	0.2
Potassium		mg/L	5.3	8.2	17.0	28.0	7.9
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L	18.0	180.0	680.0	19000.0	4.0
Acetone	3500	ug/L	< 12.0	4.0	< 60.0	< 60.0	< 10.0
Benzene	5	ug/L	< 0.6	< 0.3	< 3.0	< 3.0	< 5.0
Toluene	1000	ug/L	< 1.0	< 0.5	< 5.0	43.0	< 5.0
Vinyl chloride	2	ug/L	< 2.4	4.0	< 12.0	2600.0	21.0

+ = Compound concentration more than linear calibration range of instrument

< = Compound not detected at listed detection limit

No data indicates sample not collected.

French Limited Project

S1-131

Compound	Criteria	Units	06 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	9.4	9.0	1.4	0.1	0.8
pH		pH un	6.9	7.2	7.5	7.0	7.2
Specific Conductivity		umhos	1200.0	600.0	550.0	1300.0	1300.0
Temperature		deg C	24.0	24.0	22.0	23.0	25.0
Total Organic Carbon		ppm		< 3.0	20.8	17.0	42.7
Ammonia-N		mg/L		< 0.1	1.8	2.2	2.2
Nitrate-N		mg/L		8.6	306.0	< 0.1	0.4
Orthophosphate-P		mg/L		< 0.1	< 0.1	0.0	< 0.1
Potassium		mg/L		62.6	91.9	94.0	93.4
Arsenic	50	ug/L					
Chromium	100	ug/L					
Lead	15	ug/L					
1,2-Dichloroethane	5	ug/L		< 0.8	< 0.8	6.0	< 5.0
Acetone	3500	ug/L		< 6.0	< 6.0	17.0	< 10.0
Benzene	5	ug/L		8.0	21.0	31.0	32.0
Toluene	1000	ug/L		3.0	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L		< 1.2	< 1.2	< 1.2	< 10.0

+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

Franch Limited Project

S1-135

Compound	Criteria	Units	12 - 95	01 - 96	04 - 96	07 - 96	10 - 96
Dissolved Oxygen		ppm	0.6	1.6	1.7	0.1	0.6
pH		pH un	6.2	6.5	6.6	6.3	6.3
Specific Conductivity		umhos	420.0	350.0	300.0	450.0	1000.0
Temperature		deg C	25.0	23.0	21.0	23.0	25.0
Total Organic Carbon		ppm	52.0	< 0.5	16.4	16.0	16.5
Ammonia-N		mg/L		0.9	0.7	0.4	0.4
Nitrate-N		mg/L		< 0.2	< 0.2	< 0.1	< 0.2
Orthophosphate-P		mg/L		< 0.1	< 0.1	0.2	< 0.1
Potassium		mg/L		7.3	5.6	3.8	3.8
Arsenic	50	ug/L	195.0	169.0	40.0	62.0	69.0
Chromium	100	ug/L	13.0	13.0	< 10.0	< 10.0	< 10.0
Lead	15	ug/L	< 5.0	5.0	< 5.0	5.1	< 5.0
1,2-Dichloroethane	5	ug/L	< 0.8	< 0.8	< 0.8	< 0.8	< 5.0
Acetone	3500	ug/L	< 6.0	< 6.0	< 6.0	< 6.0	< 10.0
Benzene	5	ug/L	< 0.3	< 0.3	3.0	< 0.3	< 5.0
Toluene	1000	ug/L	< 0.5	< 0.5	< 0.5	< 0.5	< 5.0
Vinyl chloride	2	ug/L	< 1.2	< 1.2	< 1.2	< 1.2	< 10.0

\+ = Compound concentration more than linear calibration range of instrument
< = Compound not detected at listed detection limit

No data indicates sample not collected.

ATTACHMENT B

Field Duplicate Precision Summary

GROUNDWATER MONITORING
October, 1996

Field Duplicate Precision

French Ltd. Project

		S1-123		
		Samp	Dup	% RPD
Vinyl chloride	ug/L	21	21	0%
1,1-dichloroethane	ug/L	4	3	29%
1,2-dichloroethene(total)	ug/L	8	8	0%
Chloroform	ug/L	2	2	0%
1,2-dichloroethane	ug/L	4	2	67%
Trichloroethene	ug/L	3	3	0%

		INT-127		
		Samp	Dup	% RPD
Chloroethane	ug/L	200	250	22%
Methylene chloride	ug/L	4	5	22%
1,1-dichloroethane	ug/L	23	27	16%
Benzene	ug/L	200	250	22%
Toluene	ug/L	50	62	21%
Ethylbenzene	ug/L	20	26	26%
Xylene (total)	ug/L	48	58	19%

		S1-121		
		Samp	Dup	% RPD
1,2-dichloroethene(total)	ug/L	3	3	0%
1,2-dichloroethane	ug/L	3	< 5	NA
Benzene	ug/L	3	3	0%

RPD = Relative percent difference

APPENDIX B

APPENDIX B

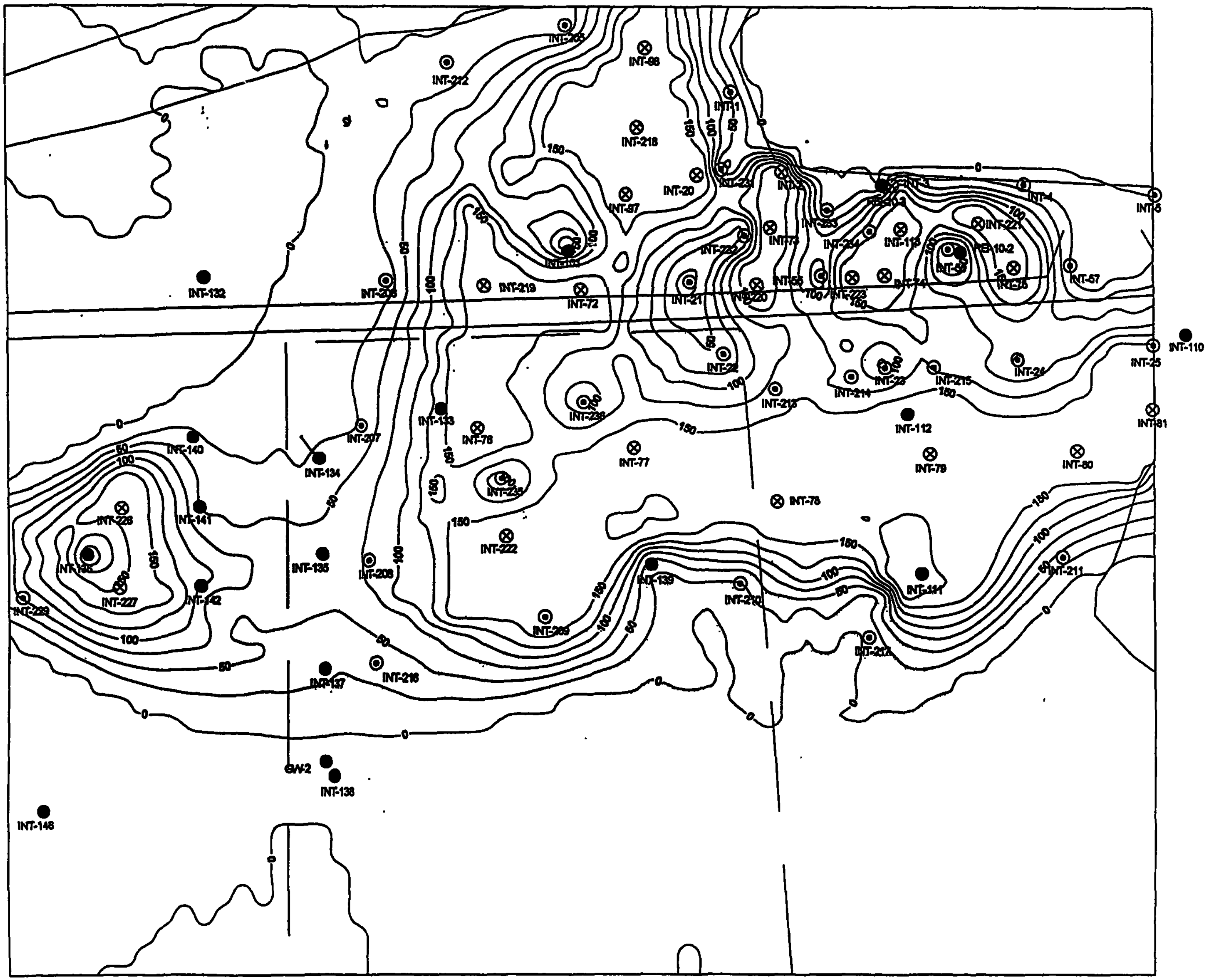
1996 modeling results

APPENDIX B-1

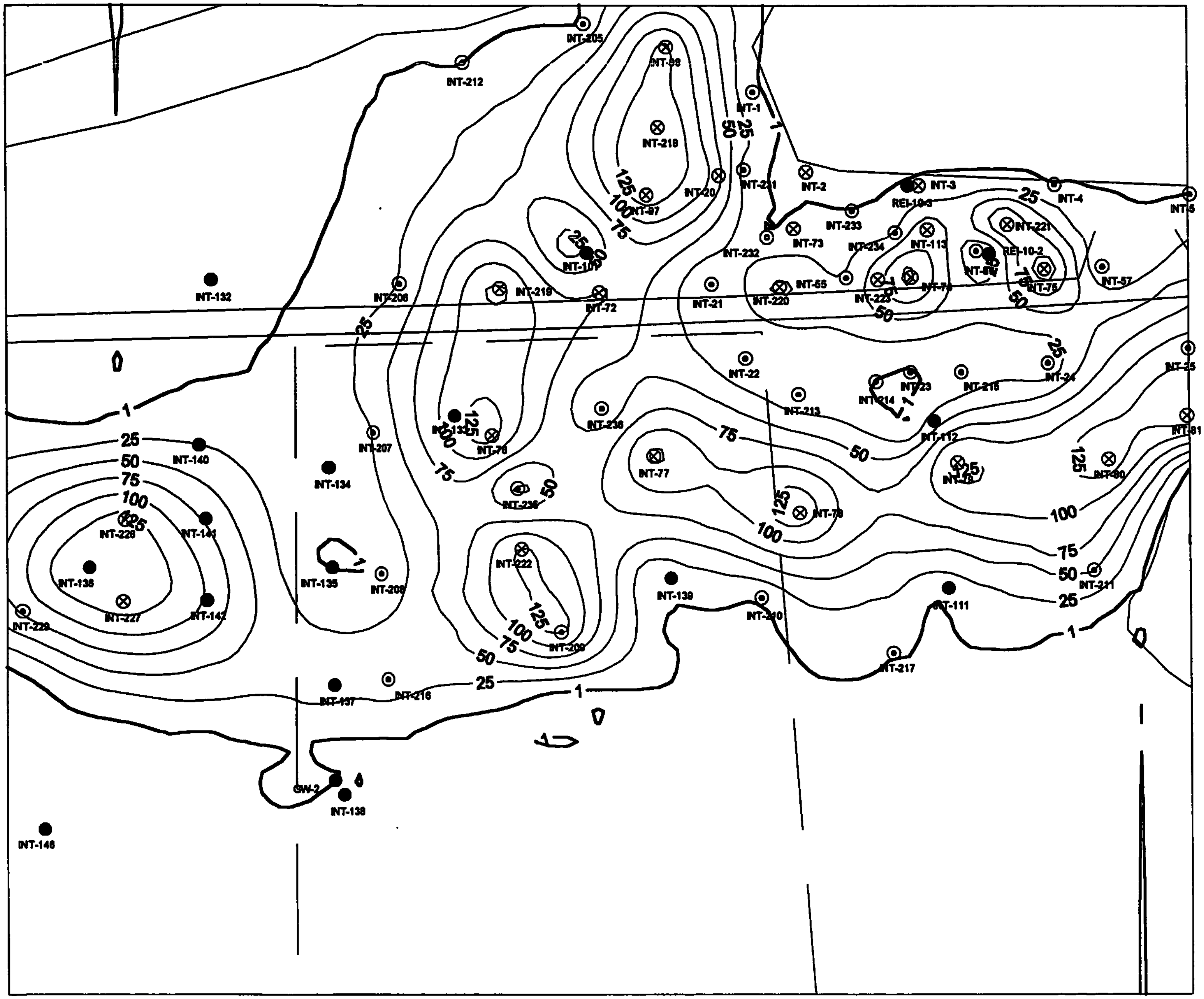
INT west area

1. DO+ initial
2. DO+ 1996
3. DO+ 2005
4. TOC initial
5. TOC 1996
6. TOC 2005
7. Benzene initial
8. Benzene 1996
9. Benzene 2005
10. 1,2-DCA initial
11. 1,2-DCA 1996
12. 1,2-DCA 2005
13. Vinyl chloride initial
14. Vinyl chloride 1996
15. Vinyl chloride 2005

INT WEST DEMONSTRATION: DO+ (ppm) INITIAL

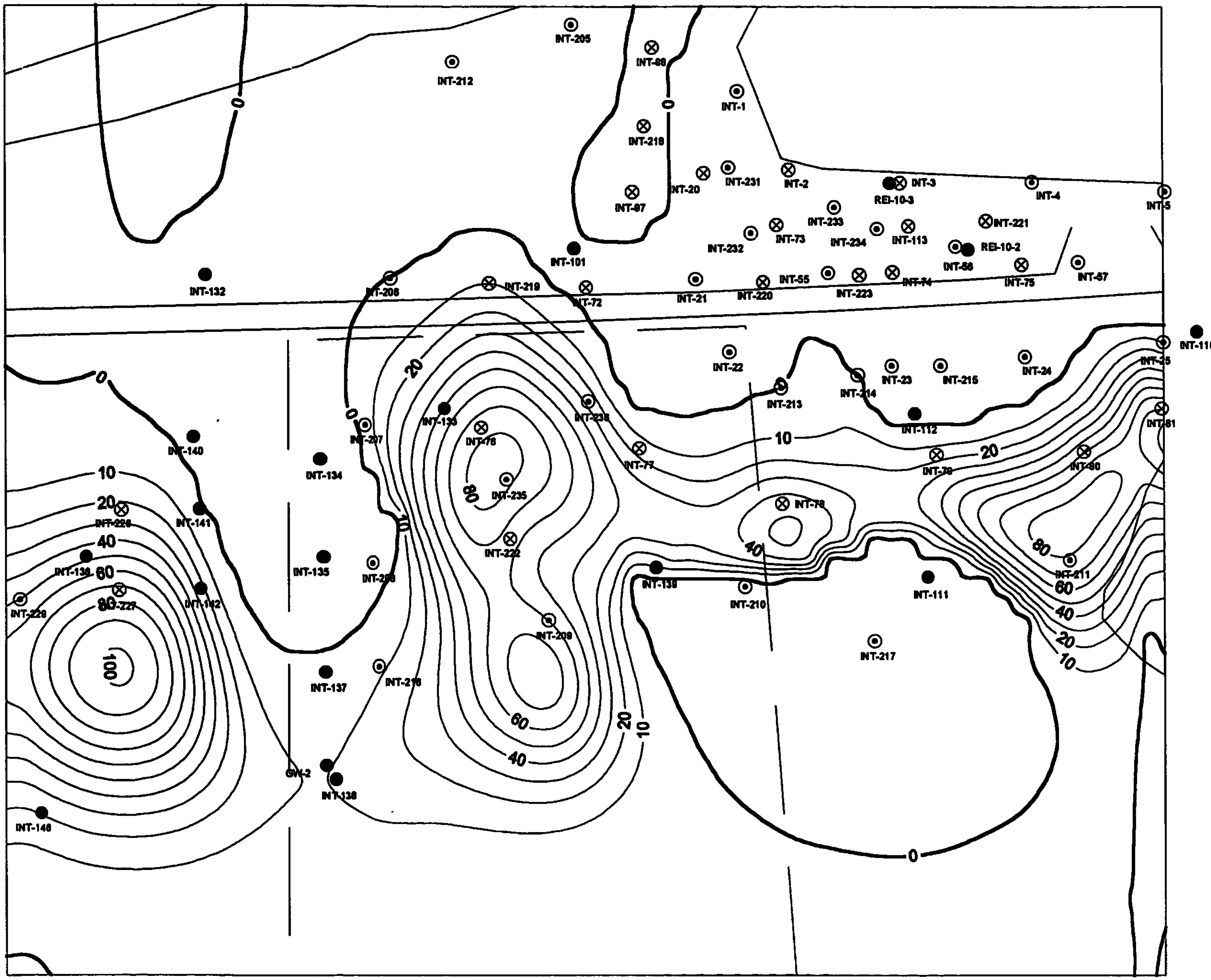


INT WEST HYBRID DEMONSTRATION: DO+ (ppm) YEAR 1996



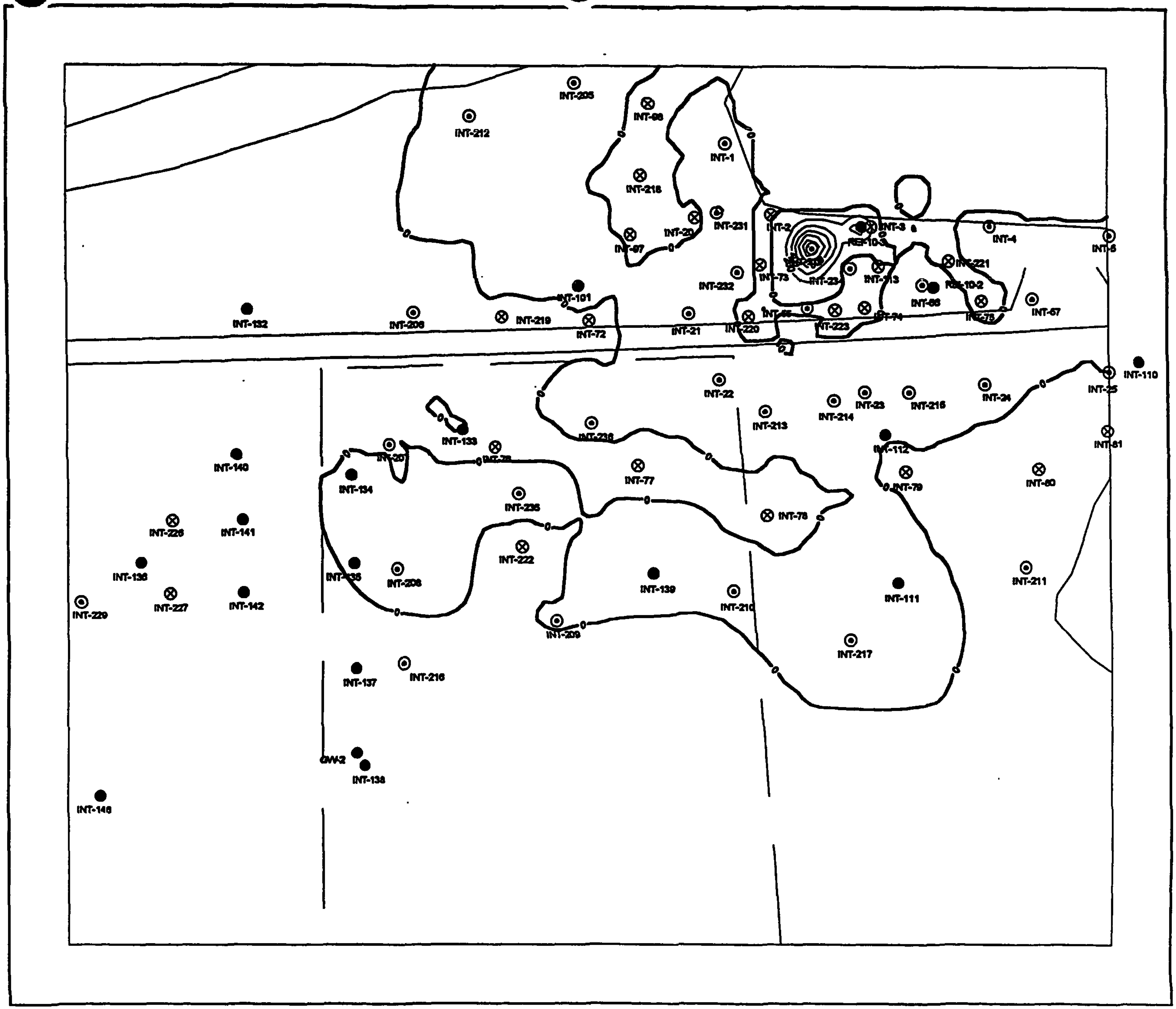
MODEL CALIBRATED USING 10/96 DATA

INT WEST DEMONSTRATION: DO+ (ppm) YEAR 2005

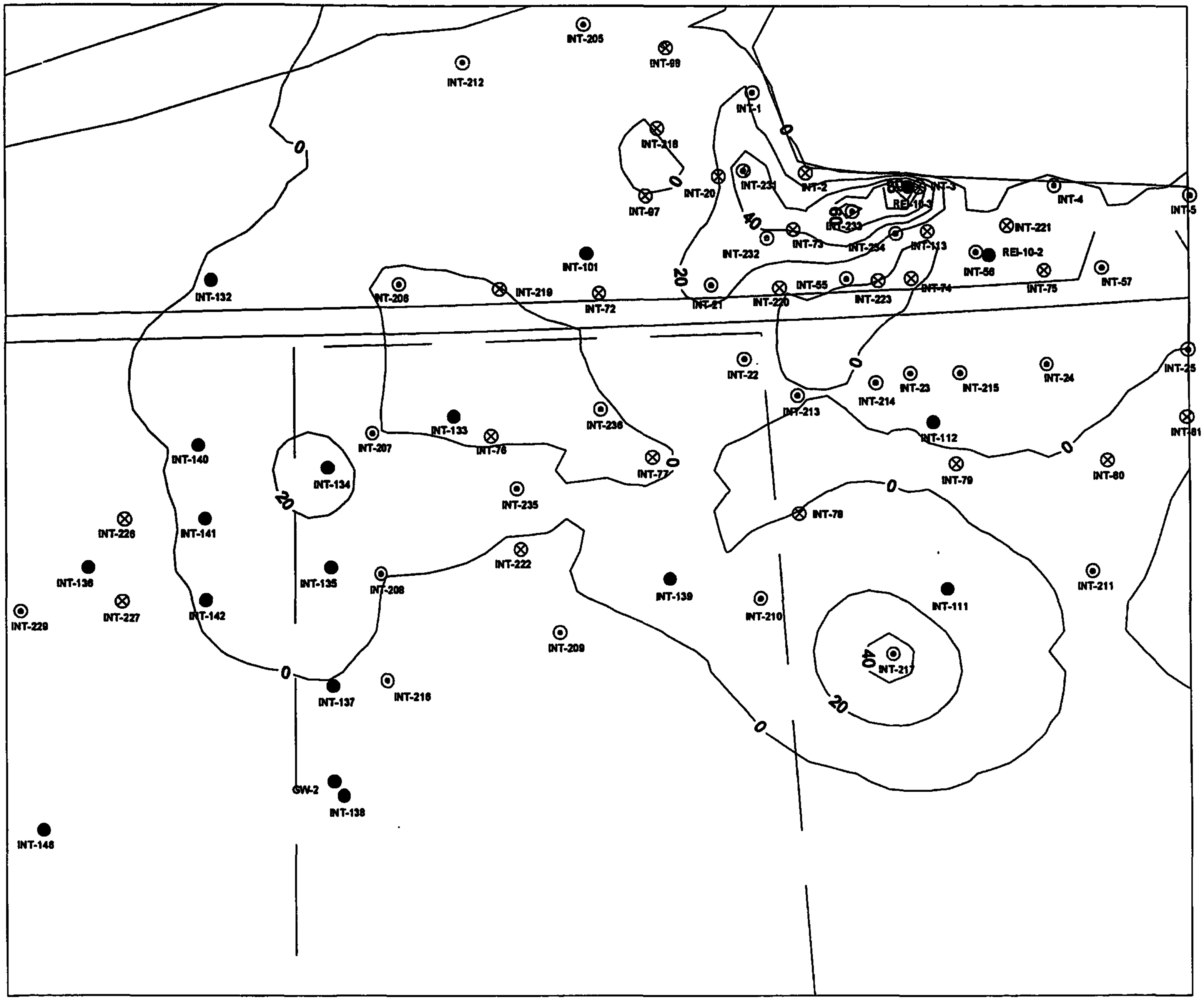


CALIBRATED USING 10/96 DATA

INT WEST DEMONSTRATION: TOC (ppm) INITIAL

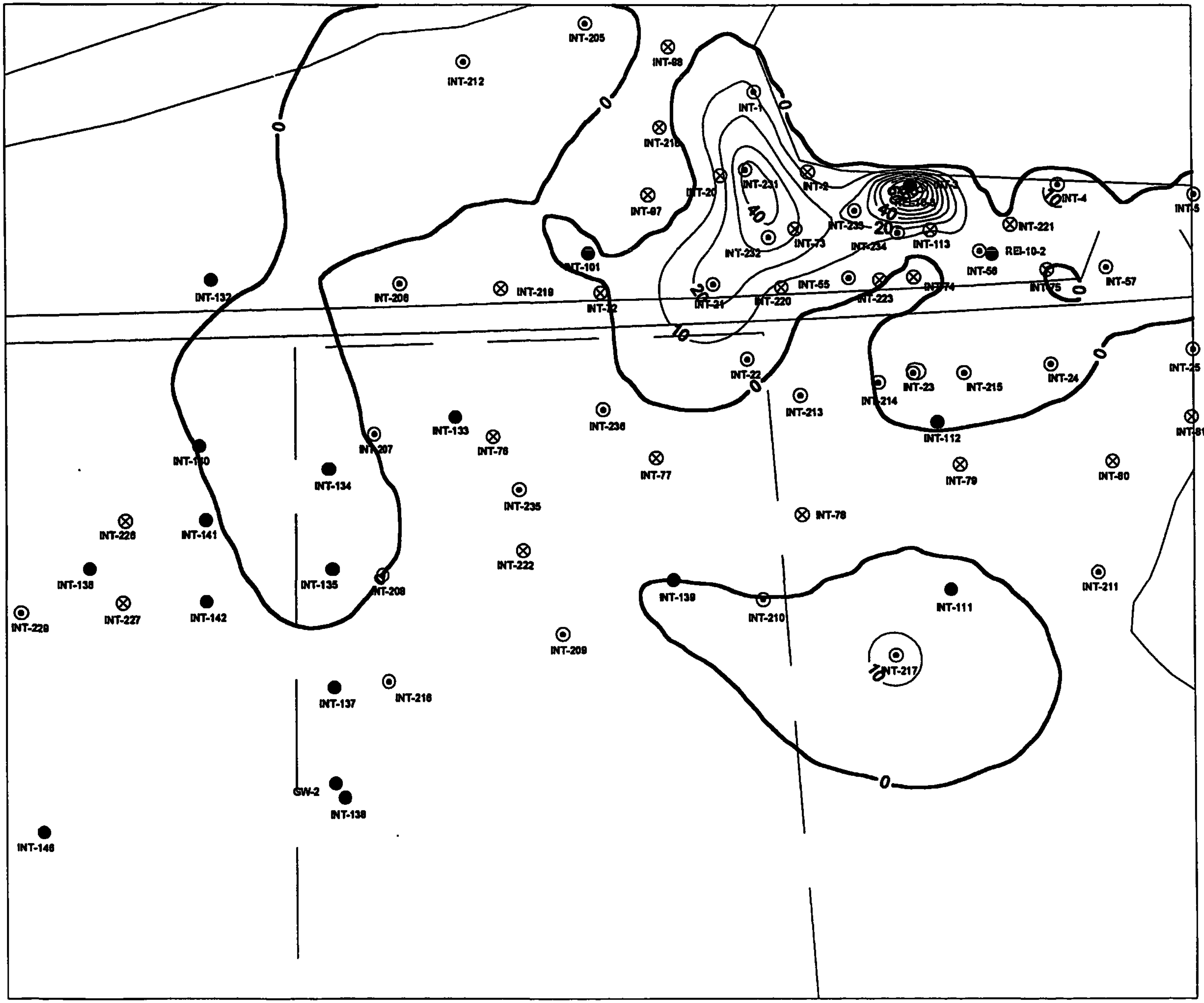


INT WEST HYBRID DEMONSTRATION: TOC (ppm) YEAR 1996



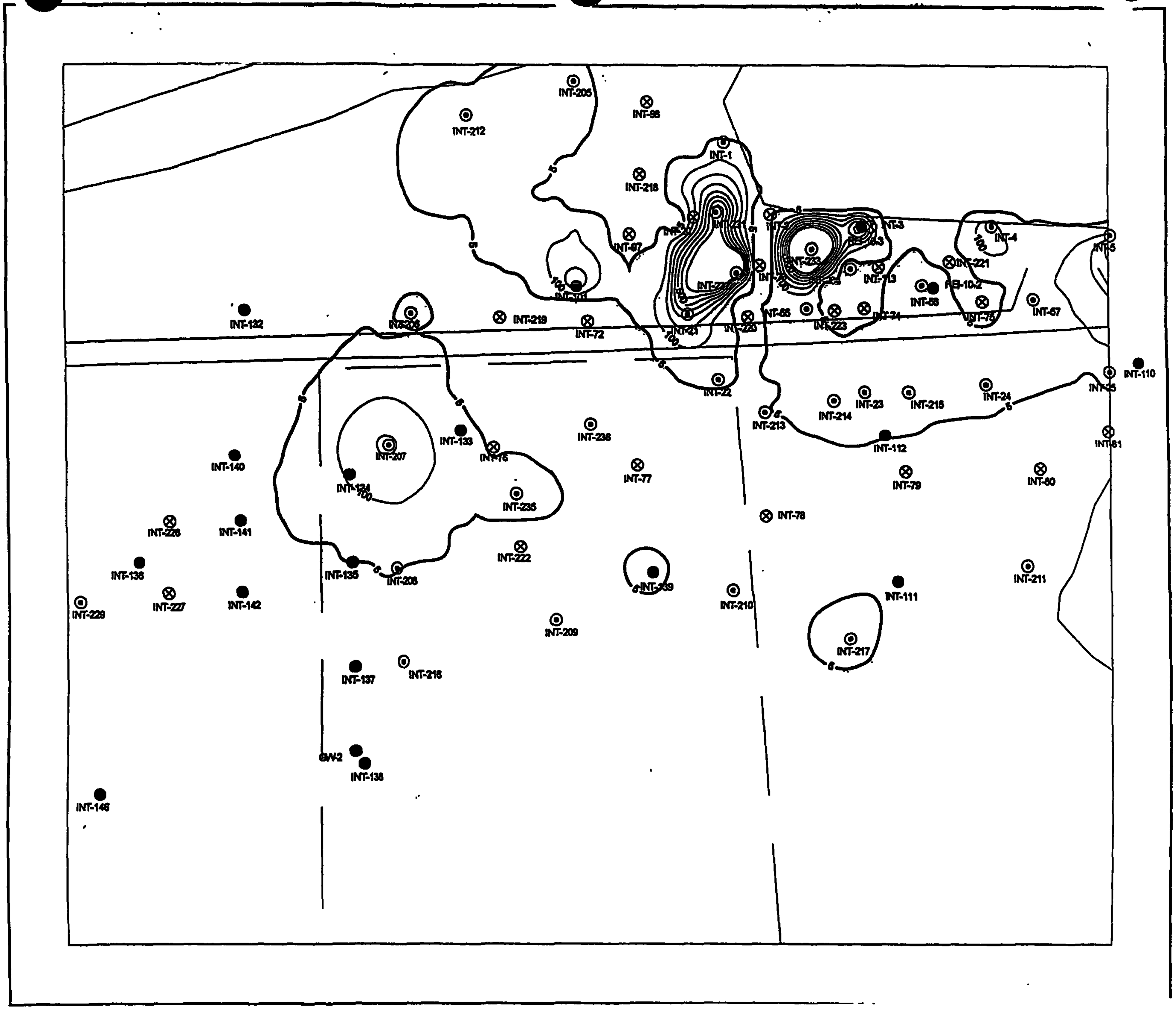
MODEL CALIBRATED USING 10/96 DATA

INT WEST DEMONSTRATION: TOC (ppm) YEAR 2005

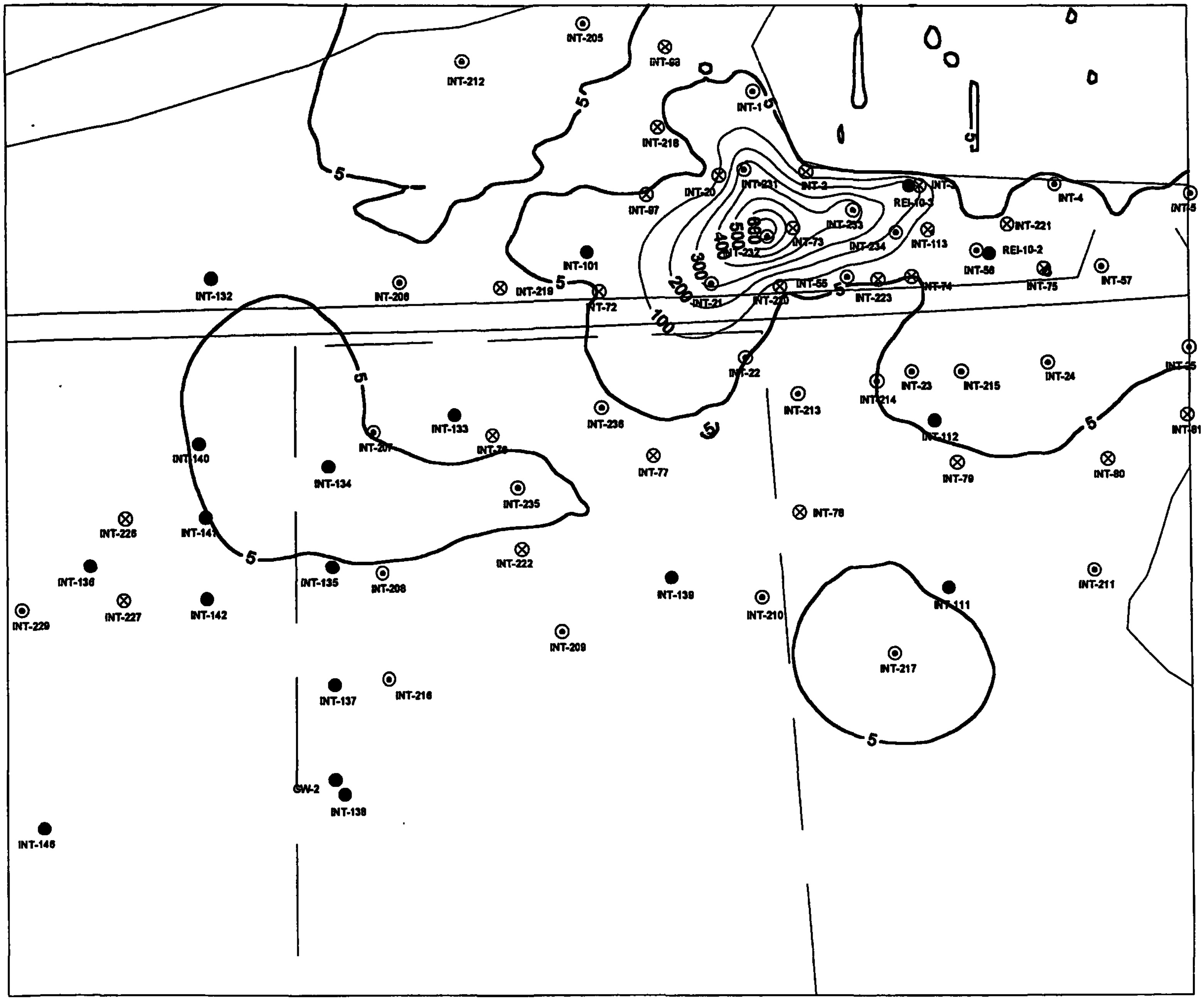


CALIBRATED USING 10/96 DATA

INT WEST DEMONSTRATION: BENZENE (ppb) INITIAL

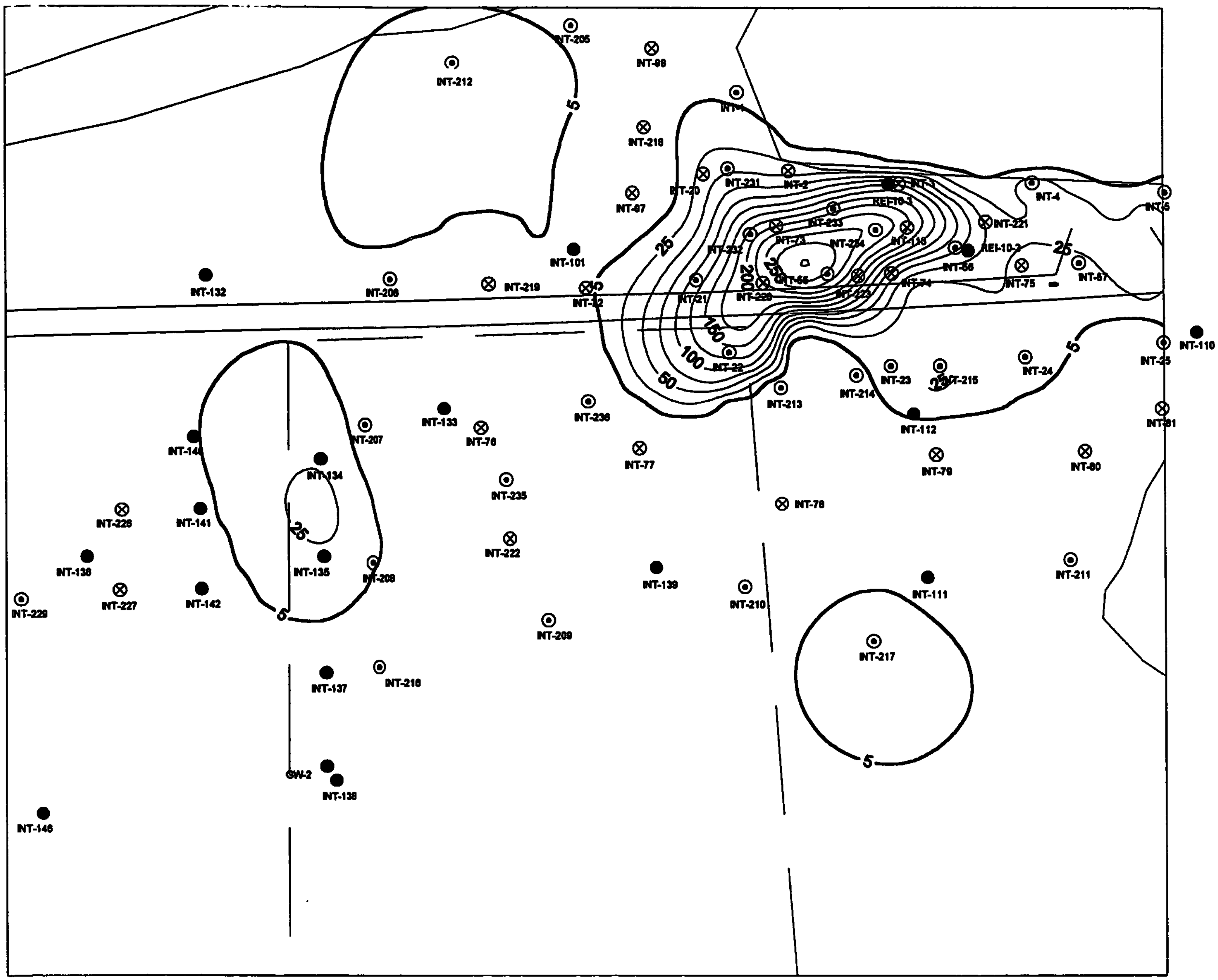


INT WEST HYBRID DEMONSTRA[illegible]ON: BENZENE (ppb) YEAR 1996



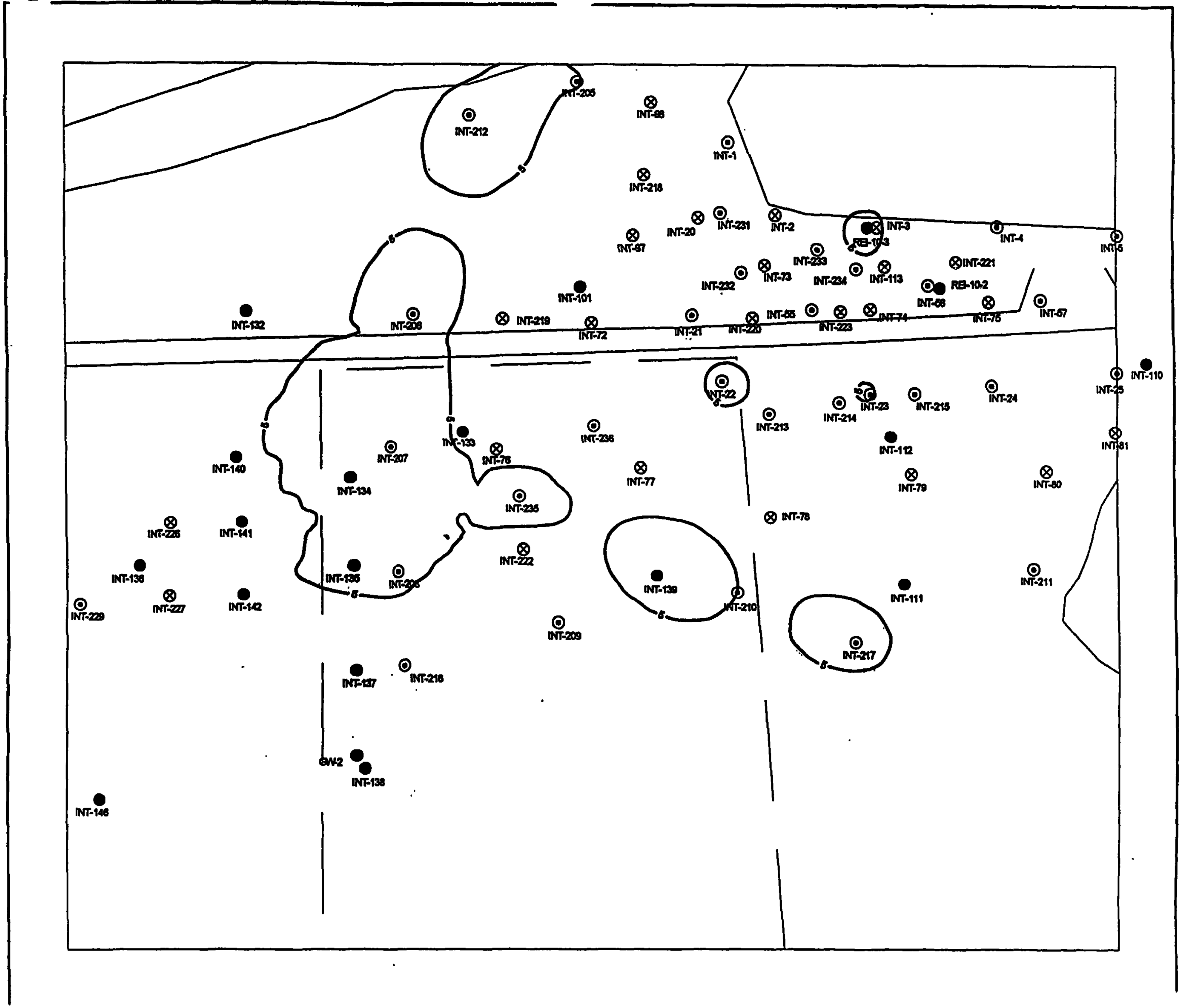
MODEL CALIBRATED USING 10/96 DATA

INT WEST DEMONSTRATION - BENZENE (ppb) YEAR 2005

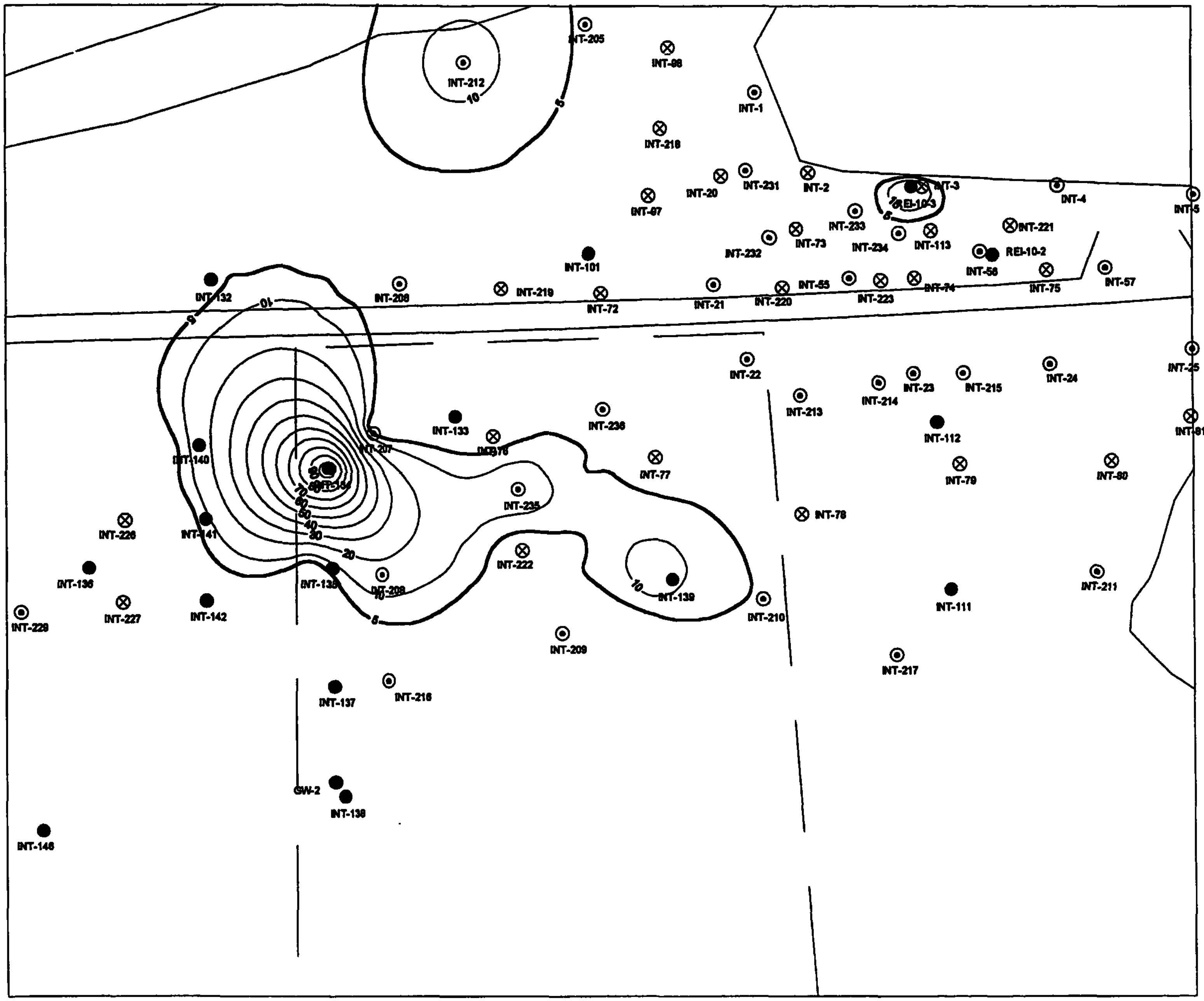


CALIBRATED USING 10/96 DATA

INT WEST DEMONSTRATION: 1,2-DCA (ppb) INITIAL

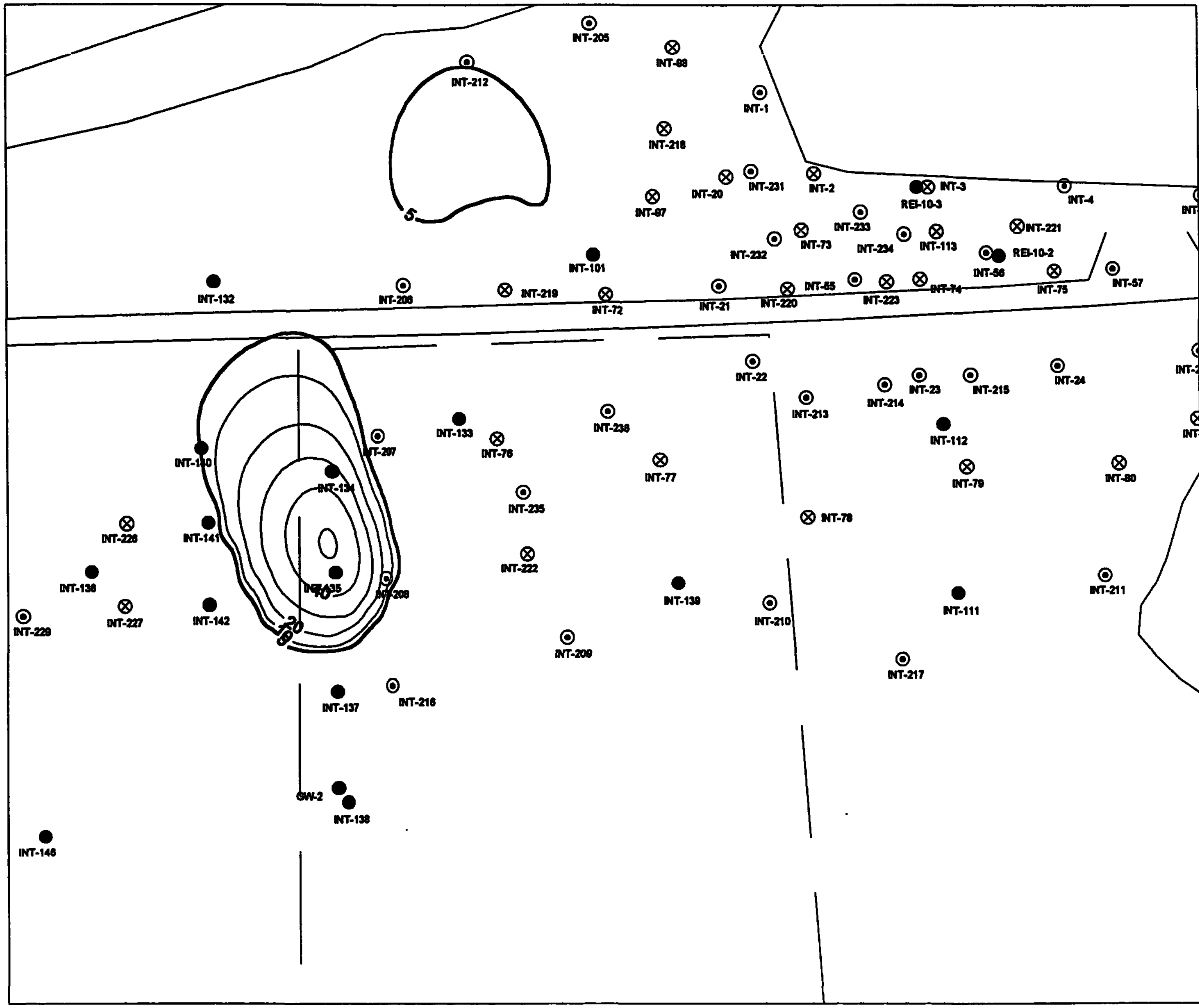


INT WEST HYBRID DEMONSTRATION: 1,2-DCA (ppb) YEAR 1996



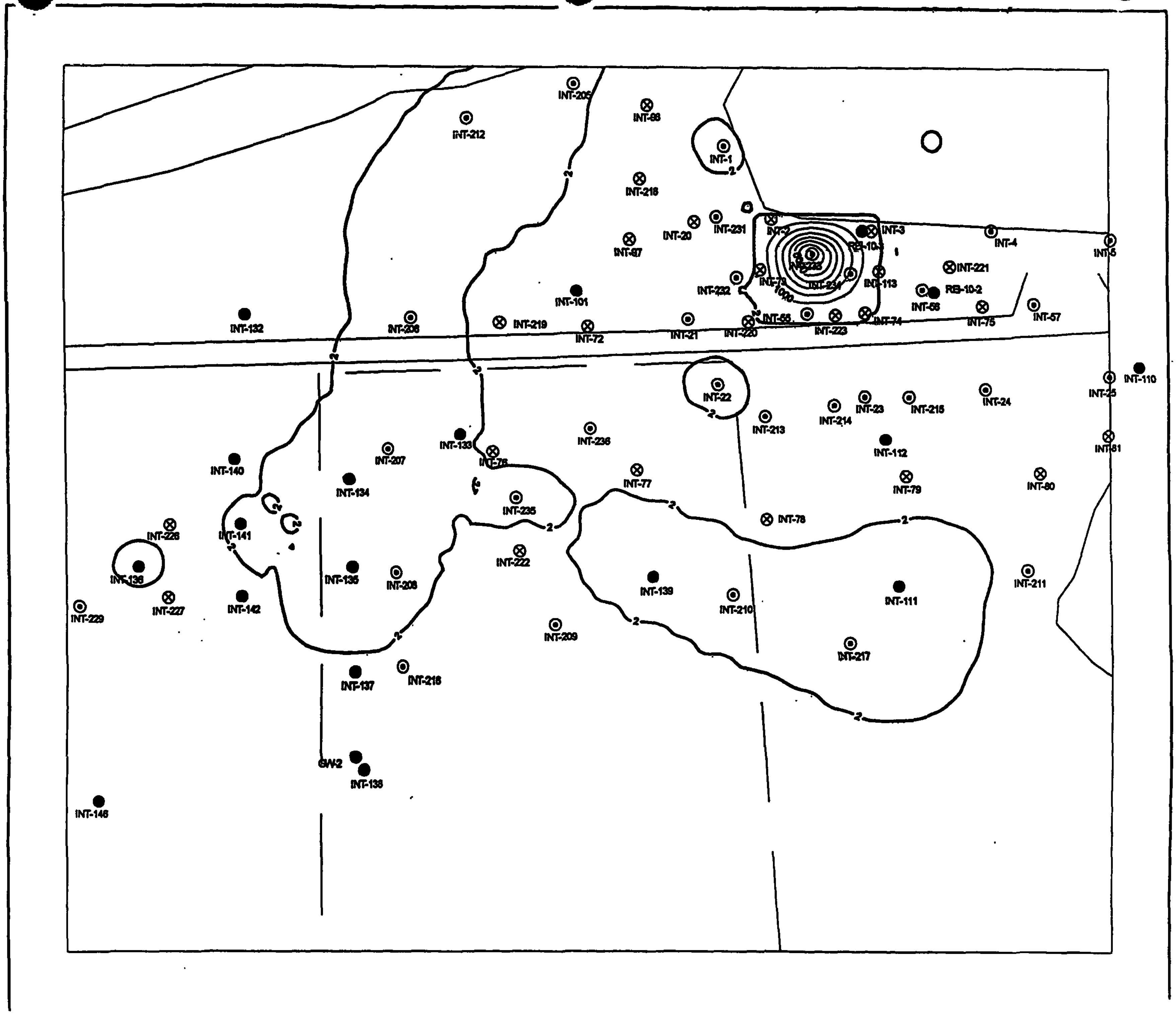
MODEL CALIBRATED USING 10/96 DATA

INT WEST DEMONSTRATION: 1,2-DCA (ppb) YEAR 2005

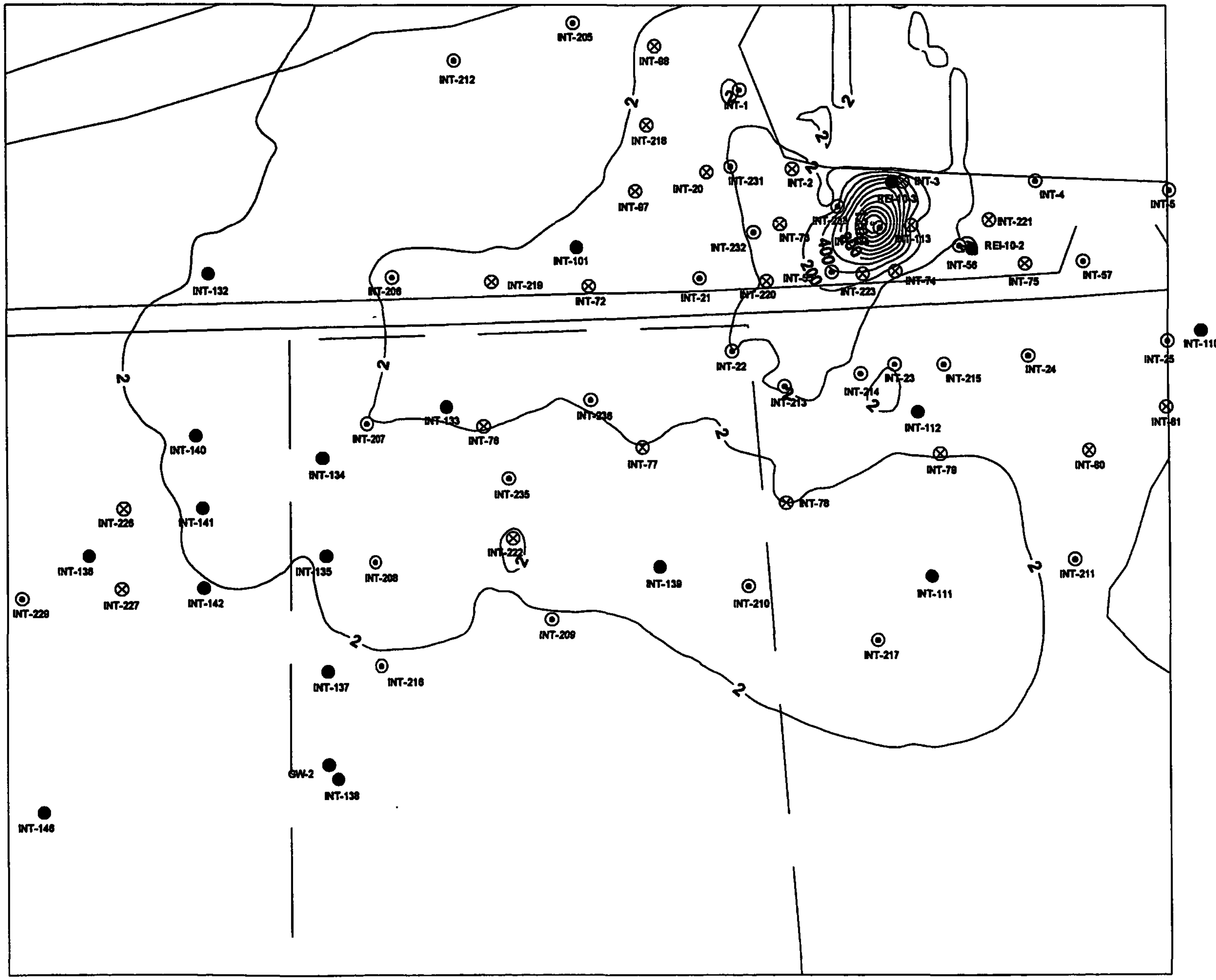


CALIBRATED USING 10/96 DATA

INT WEST DEMONSTRATI : VINYL CHLORIDE (ppb) INITIA

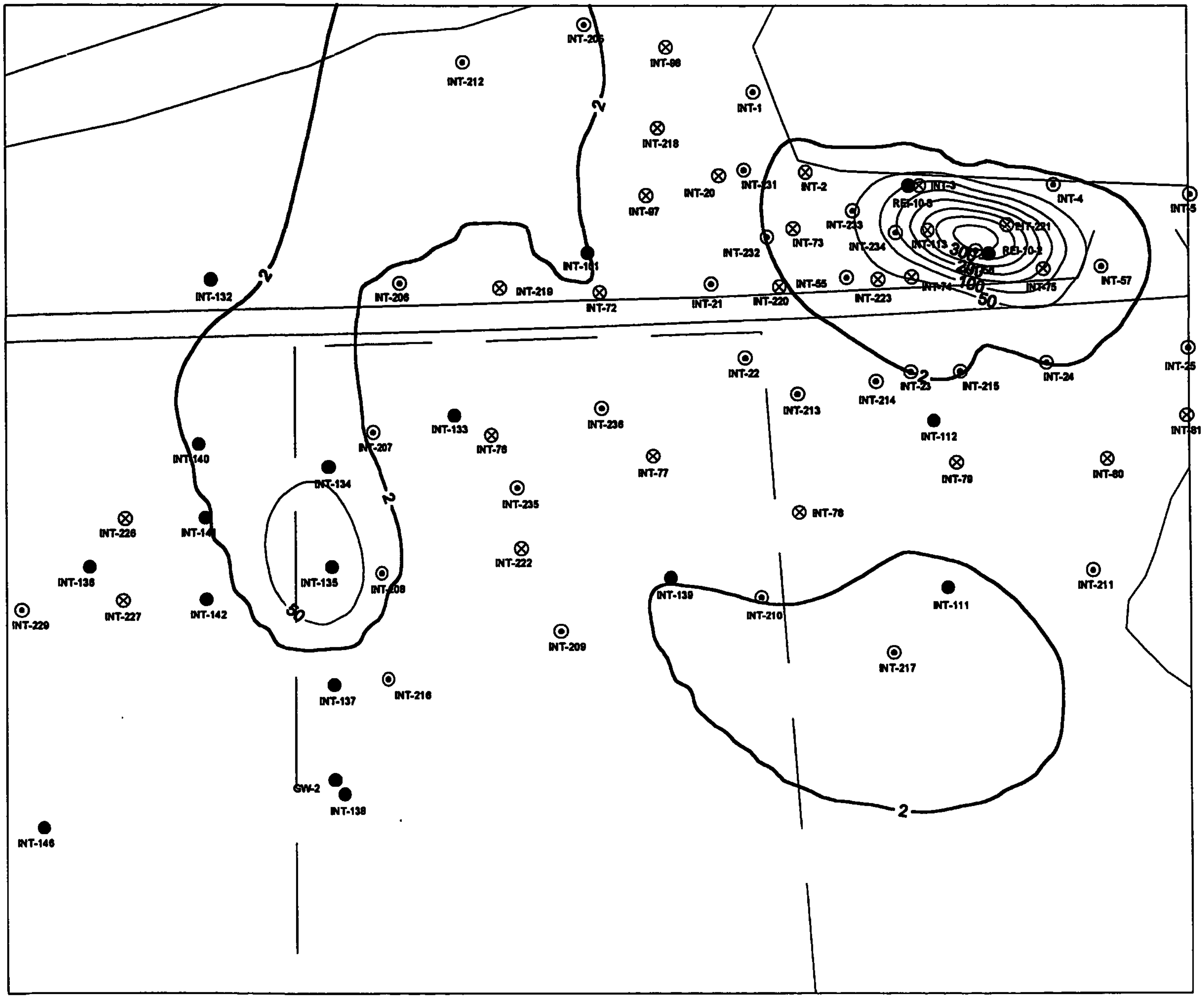


INT WEST HYBRID DEMONSTRATION: VINYL CHLORIDE (ppb) YEAR 1996



MODEL CALIBRATED USING 10/96 DATA

INT WEST DEMONSTRATION: VINYL CHLORIDE (ppb) YEAR 2005



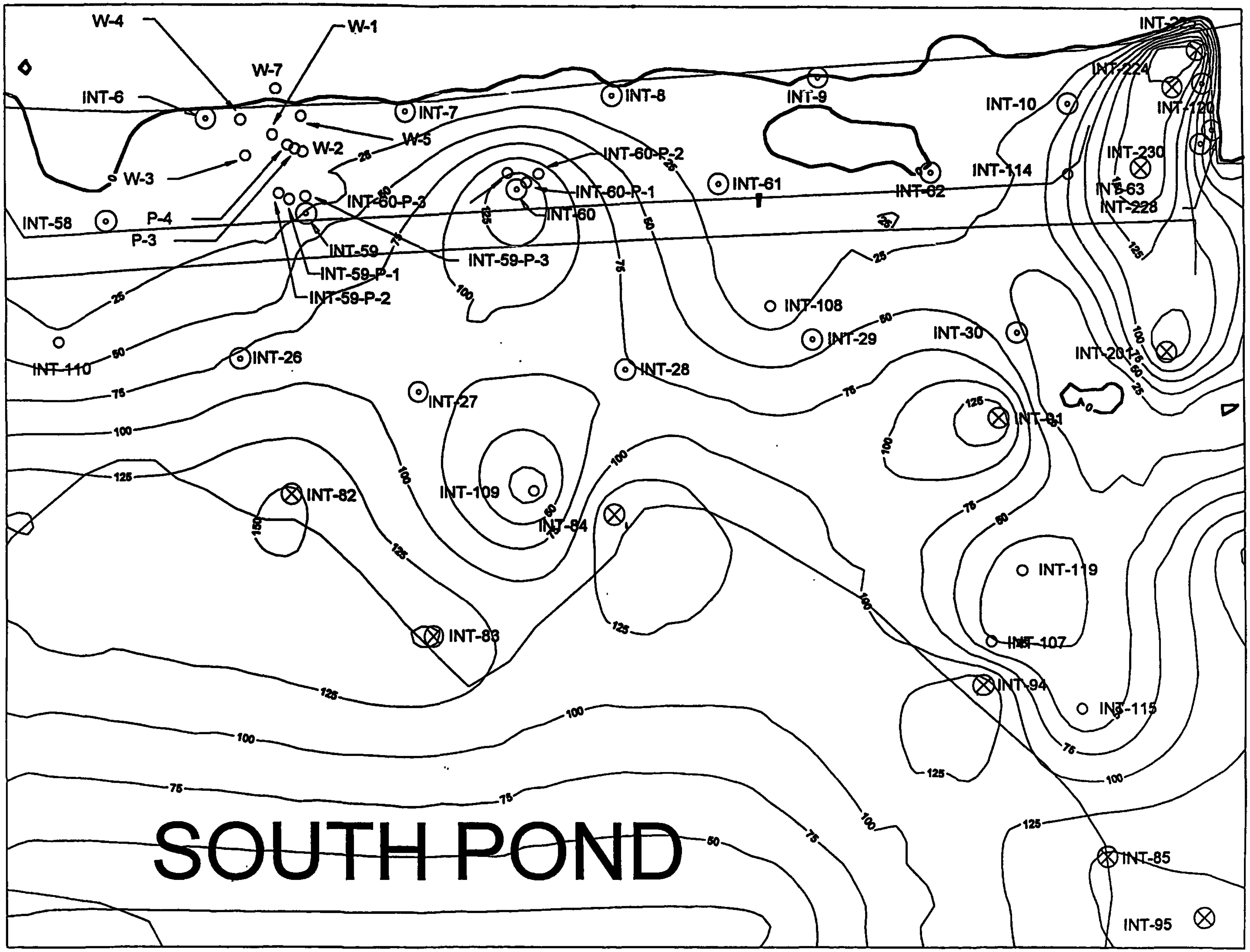
CALIBRATED USING 10/96 DATA

APPENDIX B-2

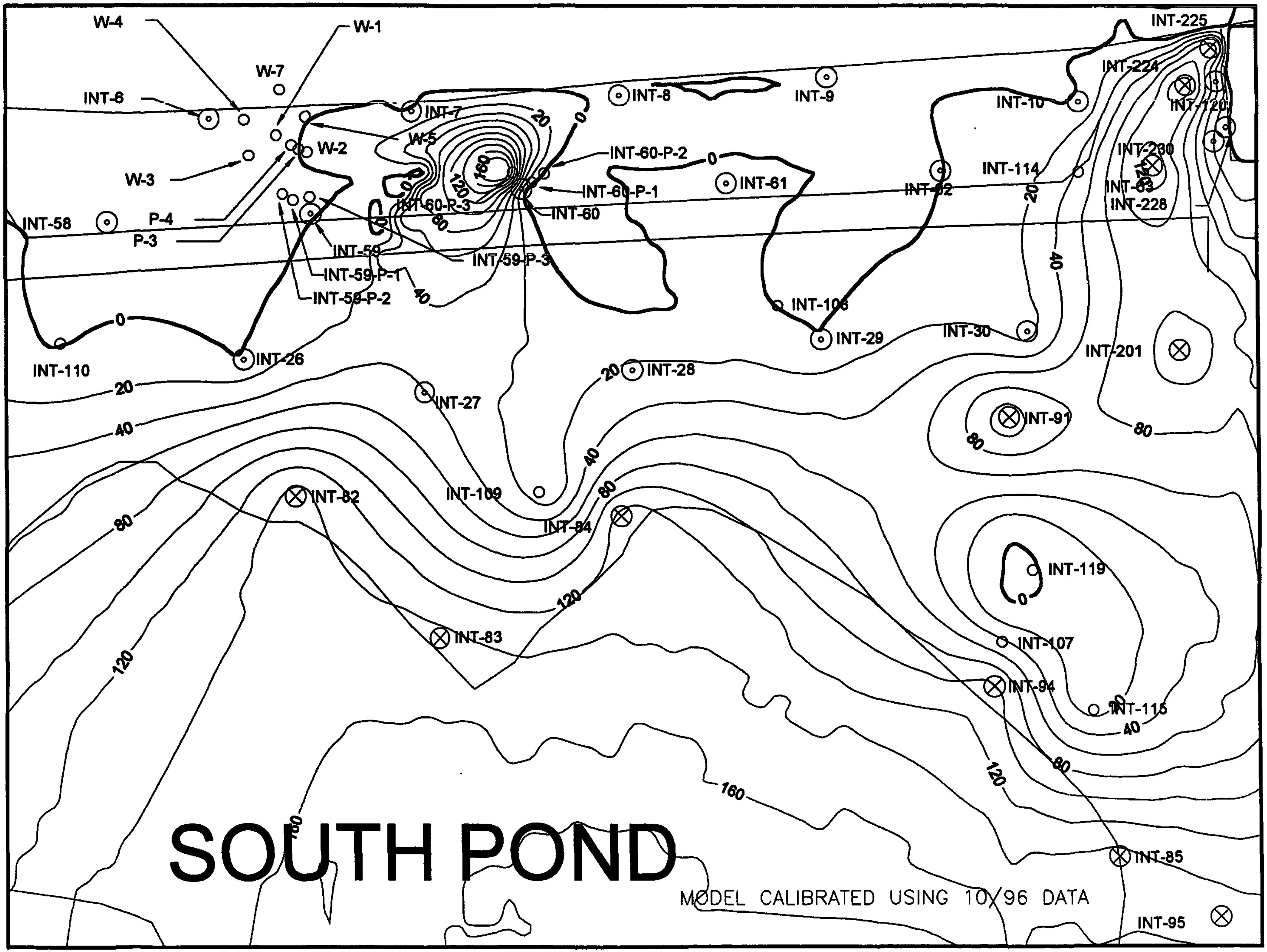
INT central area

1. DO+ initial
2. DO+ 1996
3. DO+ 2005
4. TOC initial
5. TOC 1996
6. TOC 2005
7. Benzene initial
8. Benzene 1996
9. *Benzene 2005*
10. 1,2-DCA initial
11. 1,2-DCA 1996
12. 1,2-DCA 2005
13. Vinyl chloride initial
14. Vinyl chloride 1996
15. Vinyl chloride 2005

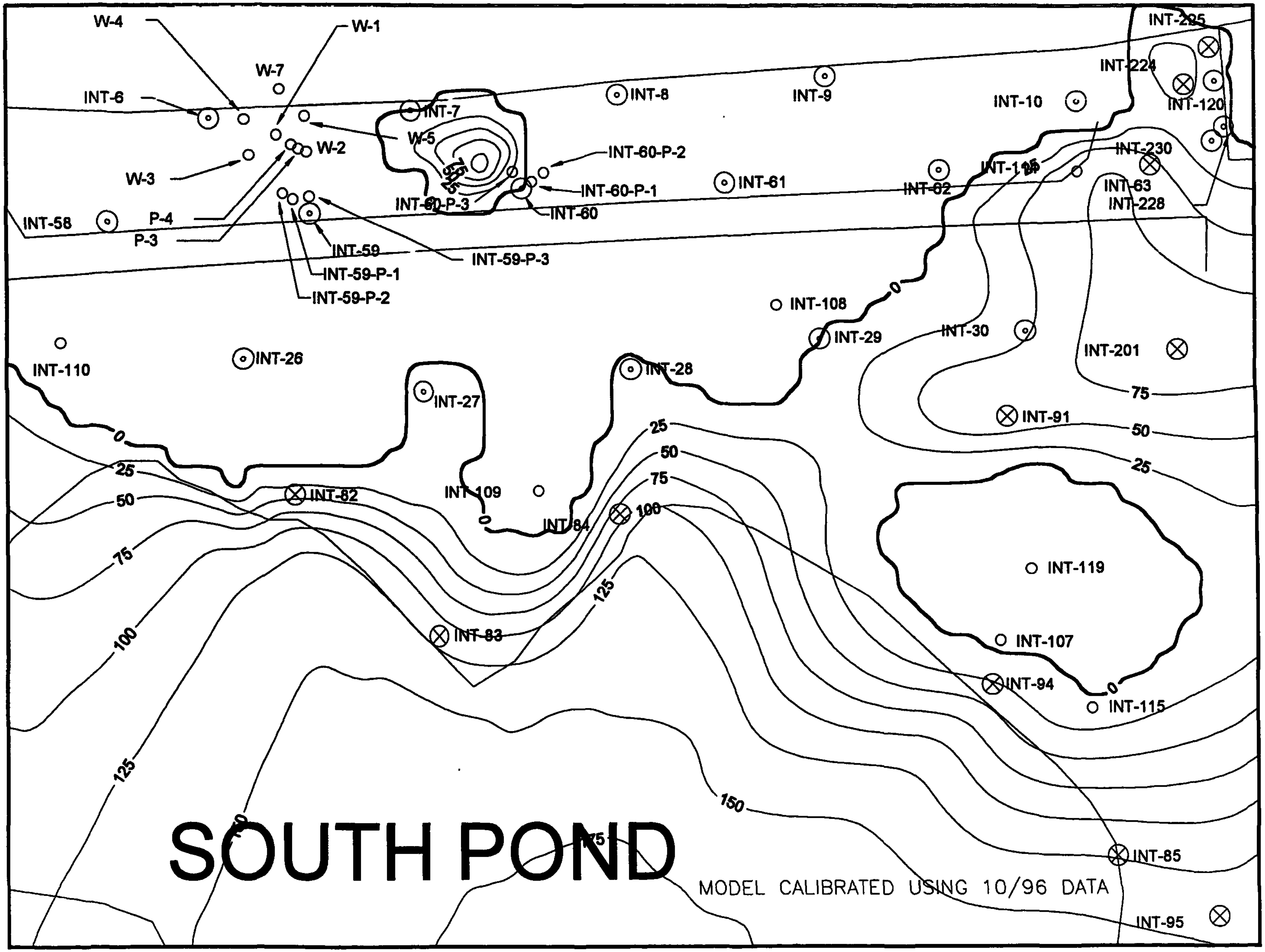
INT CENTRAL DEMONSTRATION: DO+ (ppm) INITIAL



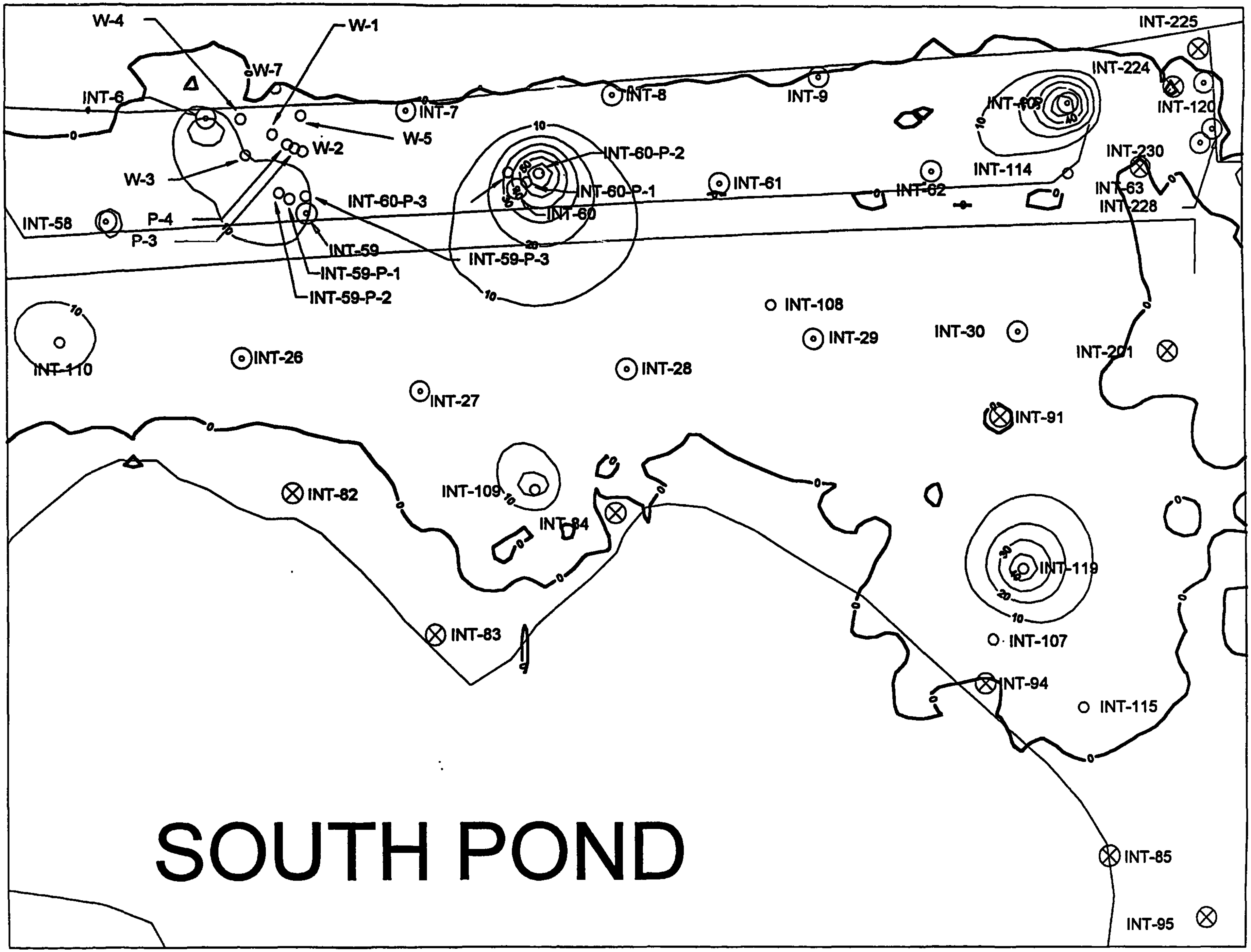
INT CENTRAL HYBRID DEMONSTRATION: DO+ (ppm) YEAR 1996



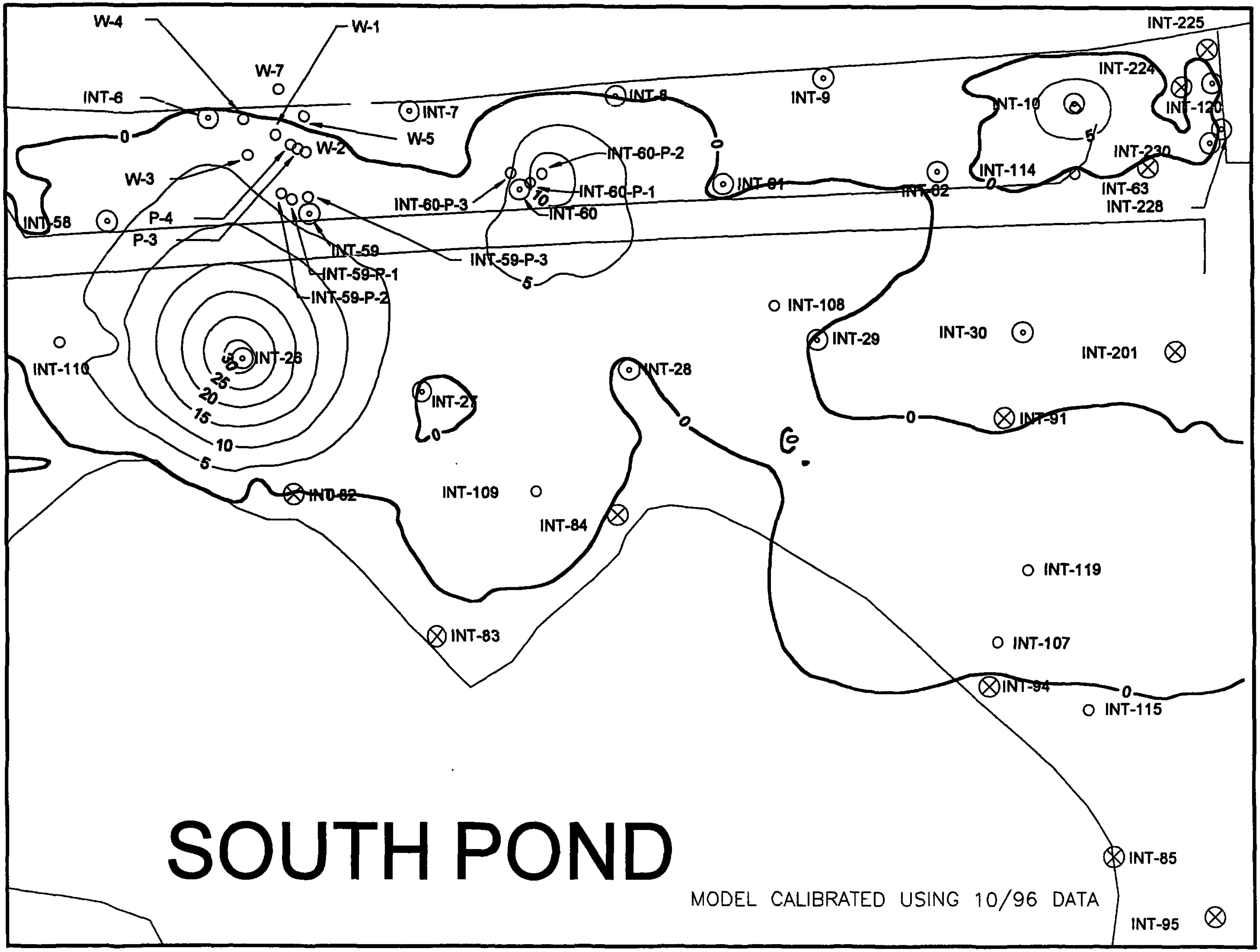
INT CENTRAL DEMONSTRATION: DO+ (ppm) YEAR 2005



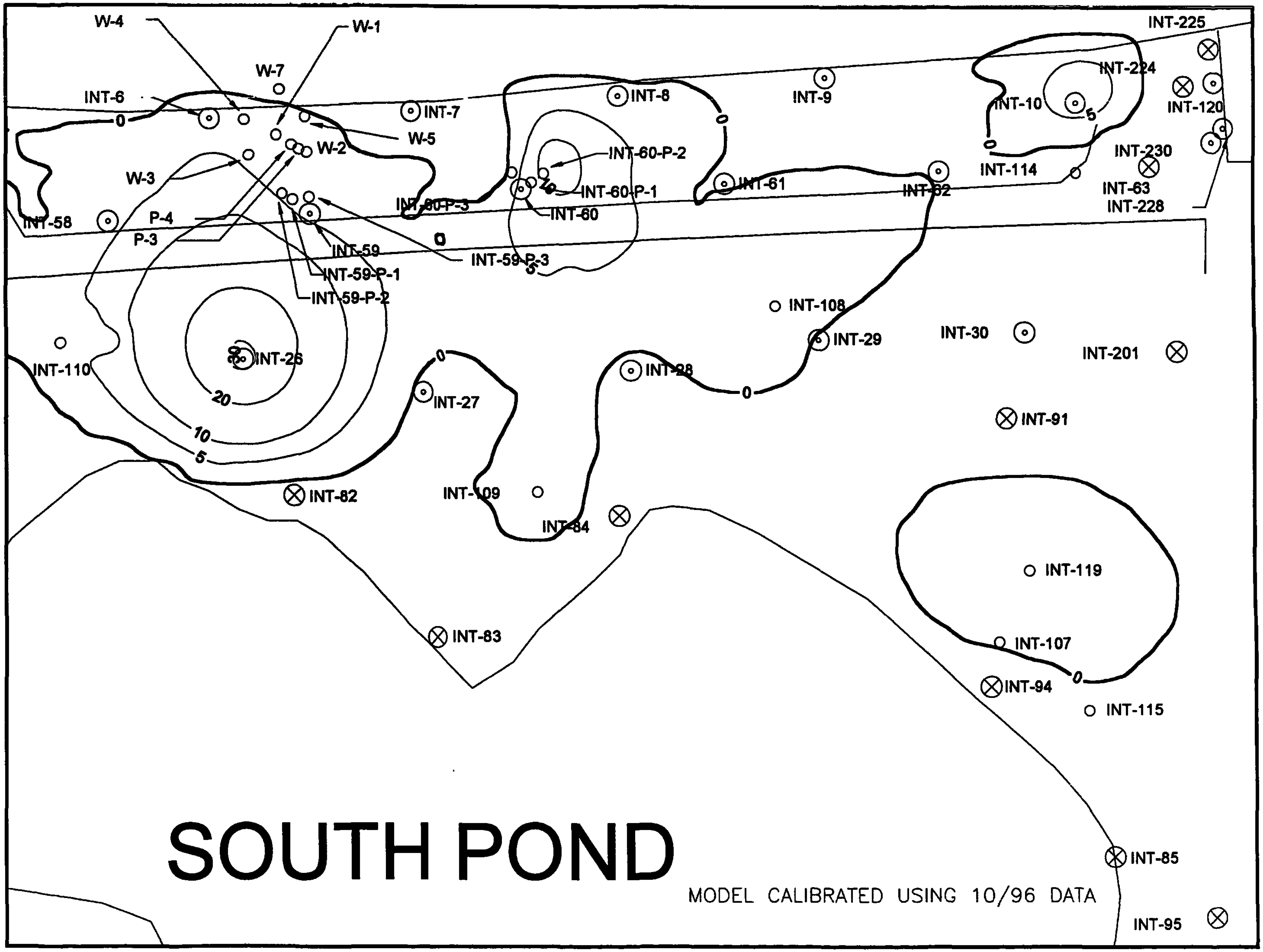
INT CENTRAL DEMONSTRATION: TOC (ppm) INITIAL



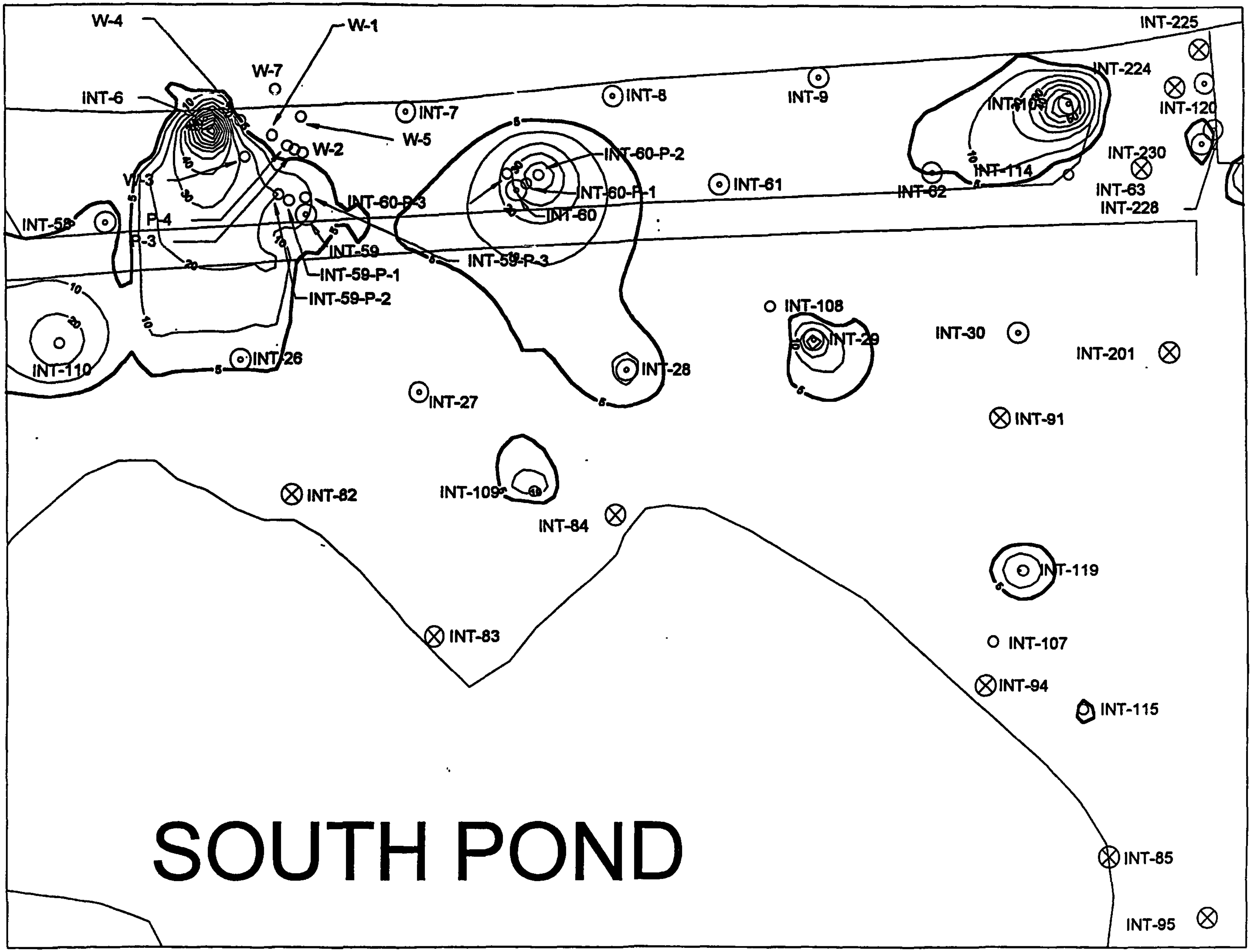
INT CENTRAL HYBRID DEMONSTRATION: TOC (ppm) YEAR 1996



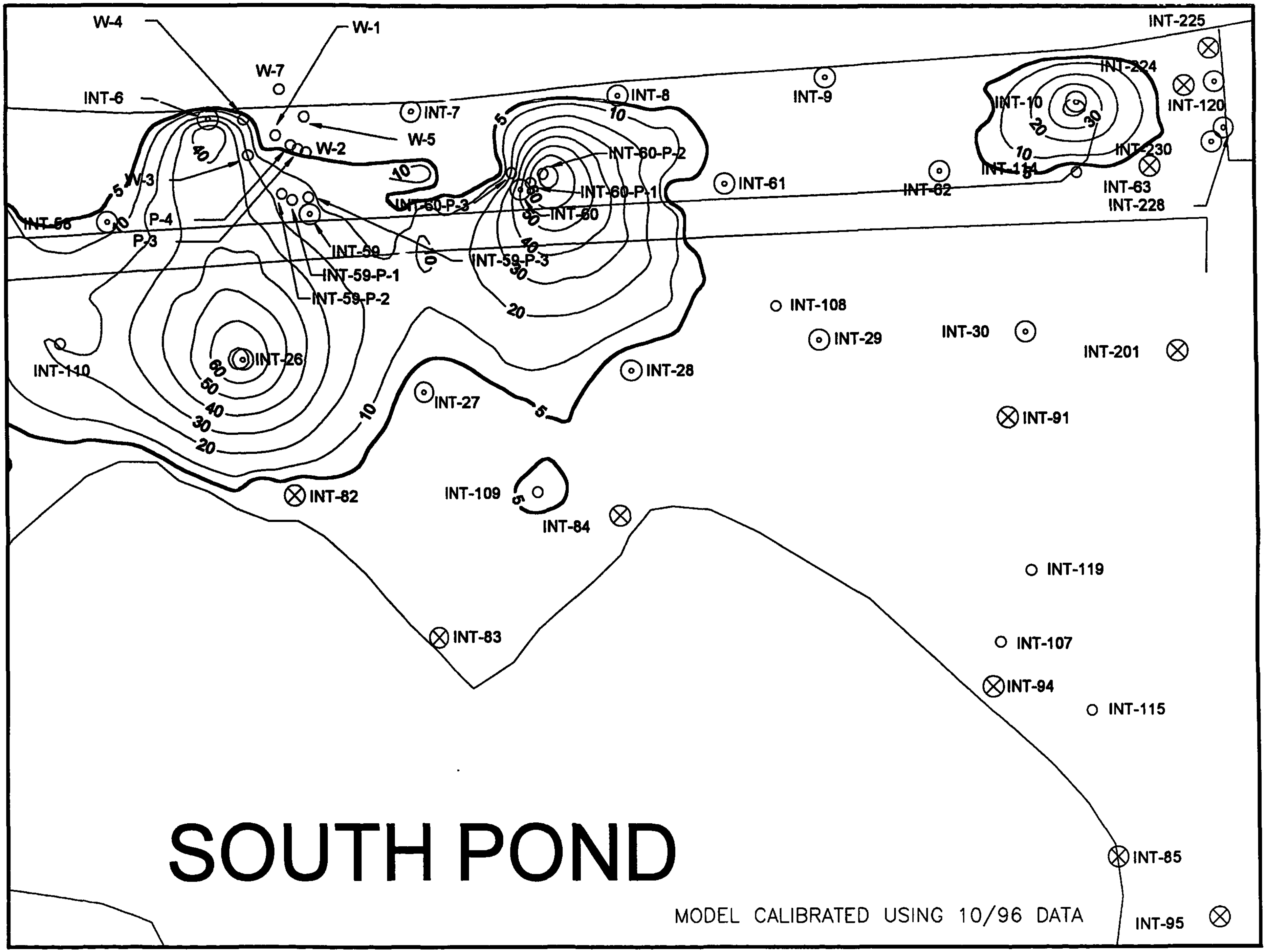
INT CENTRAL DEMONSTRATION: TOC (ppm) YEAR 2005



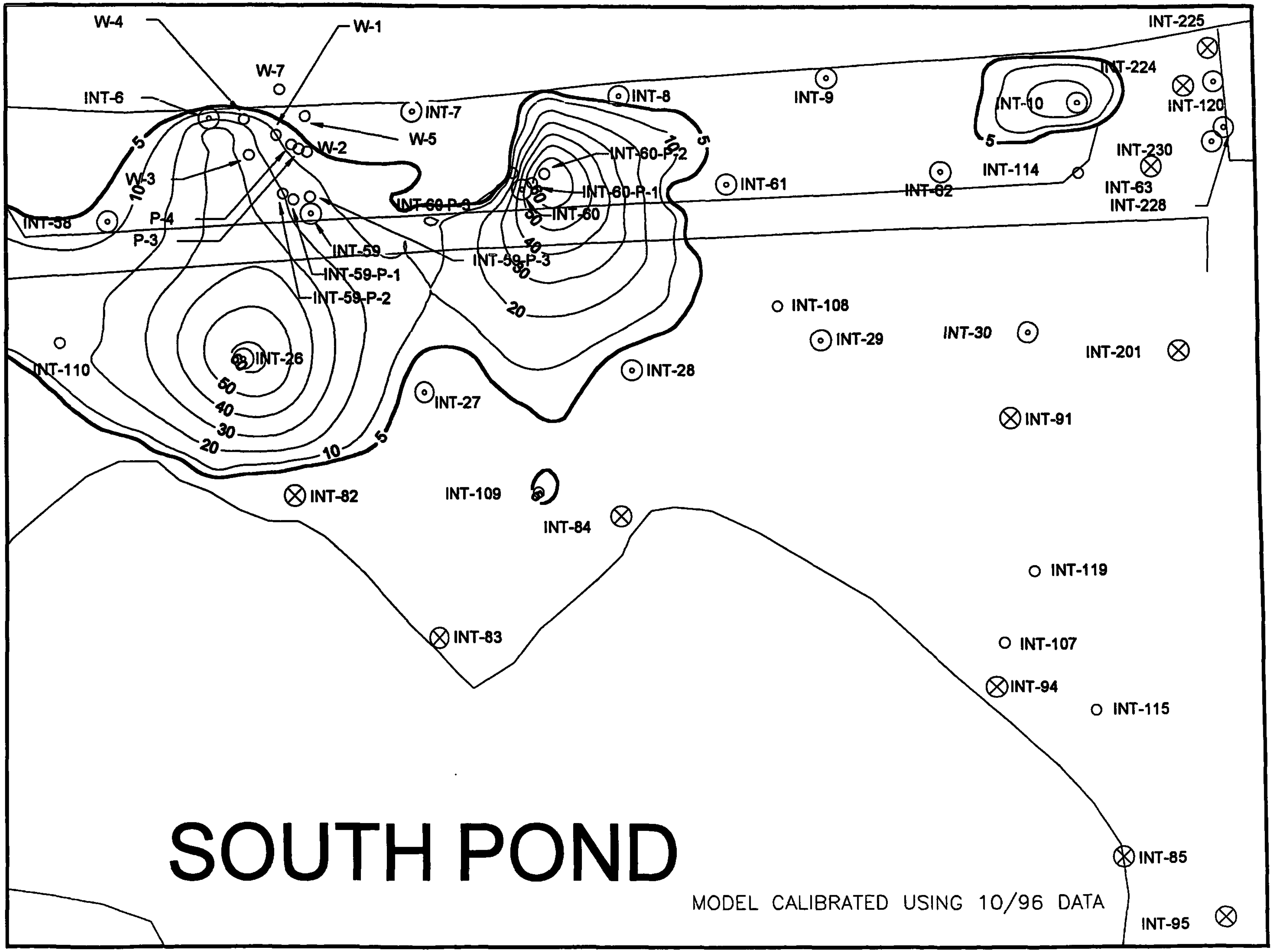
T CENTRAL DEMONSTRA ION: BENZENE (ppb) INITI



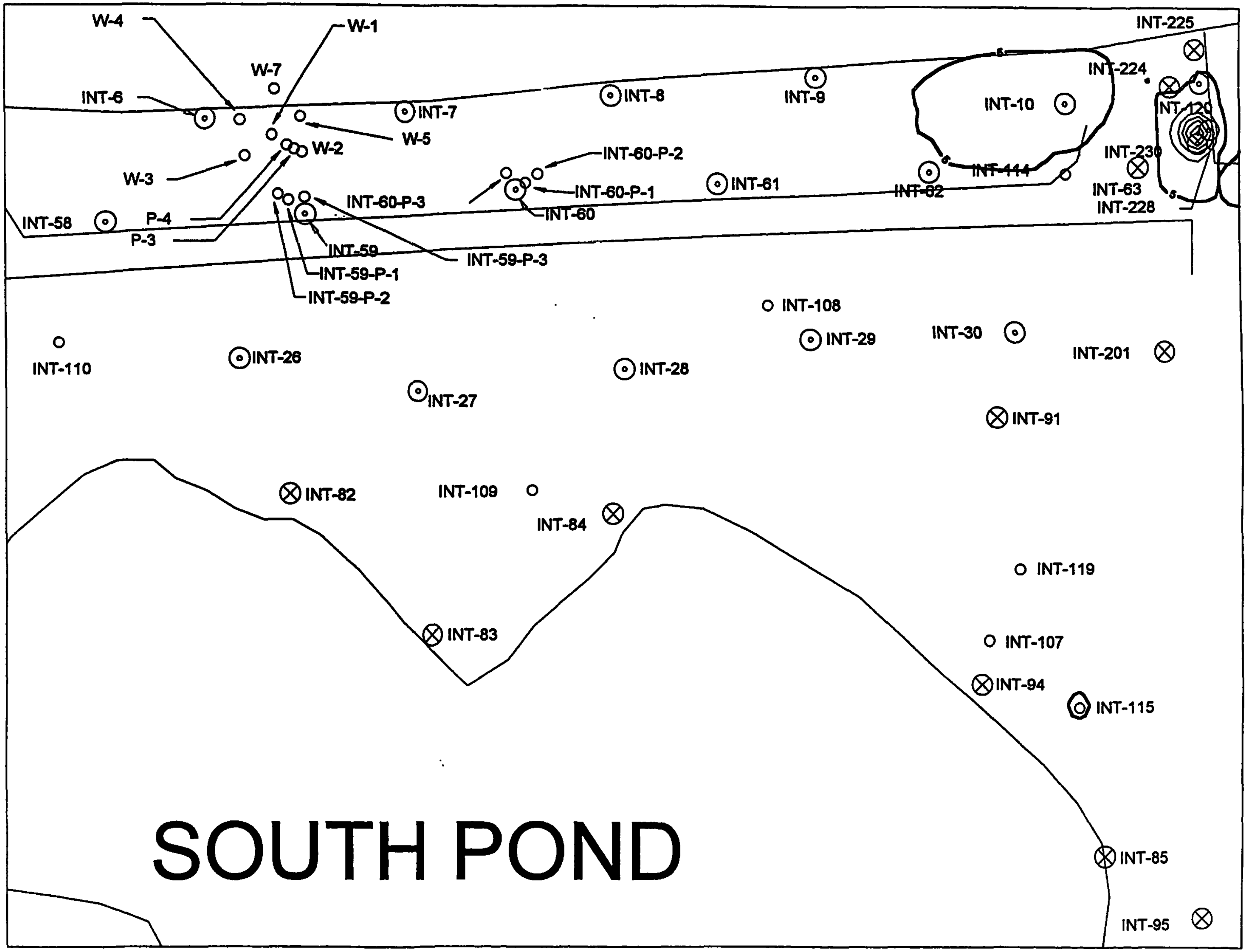
INT CENTRAL HYBRID DEMONSTRATION: BENZENE (ppb) YEAR 1996



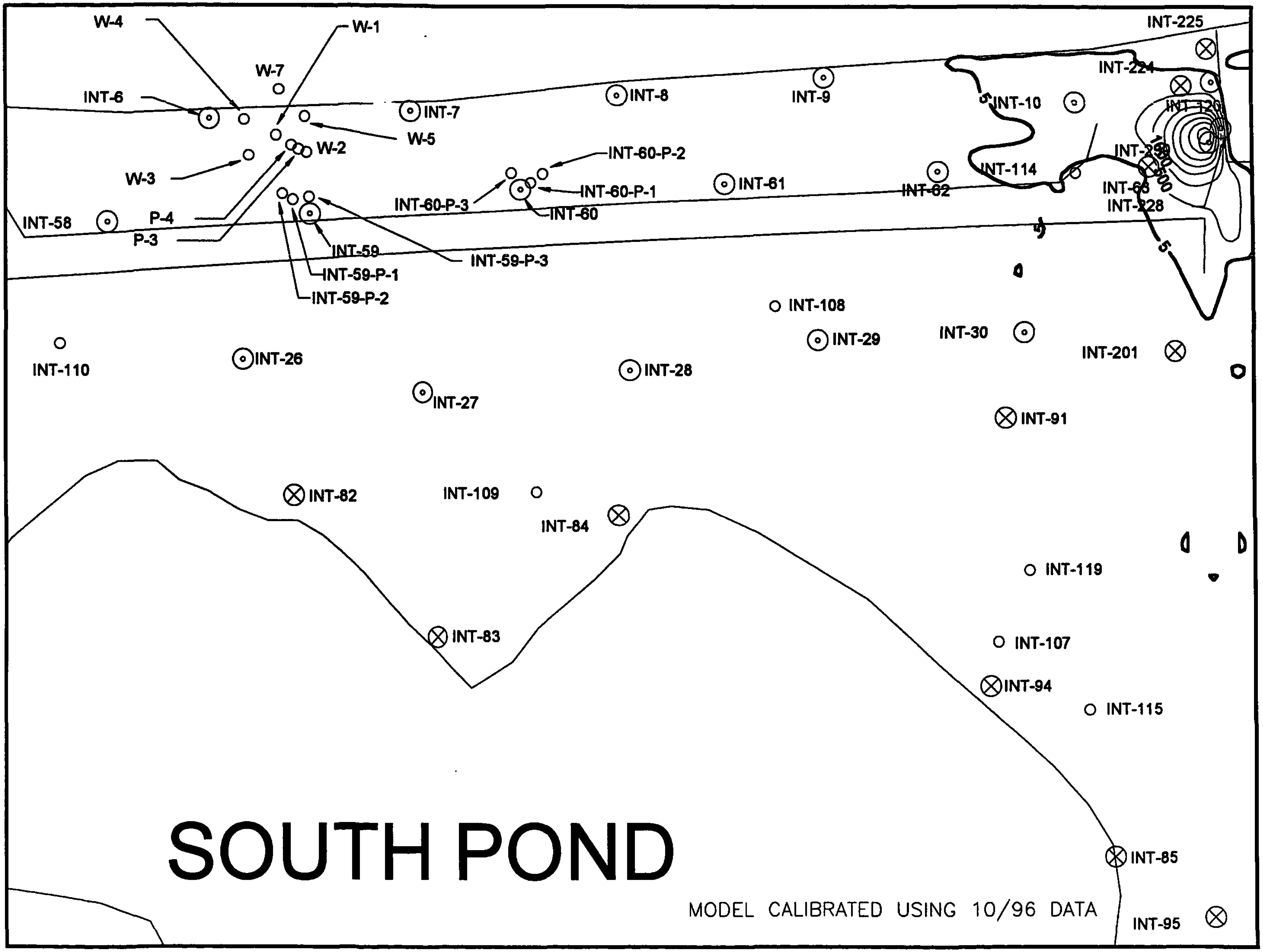
INT CENTRAL DEMONSTRATION: BENZENE (ppb) YEAR 2005



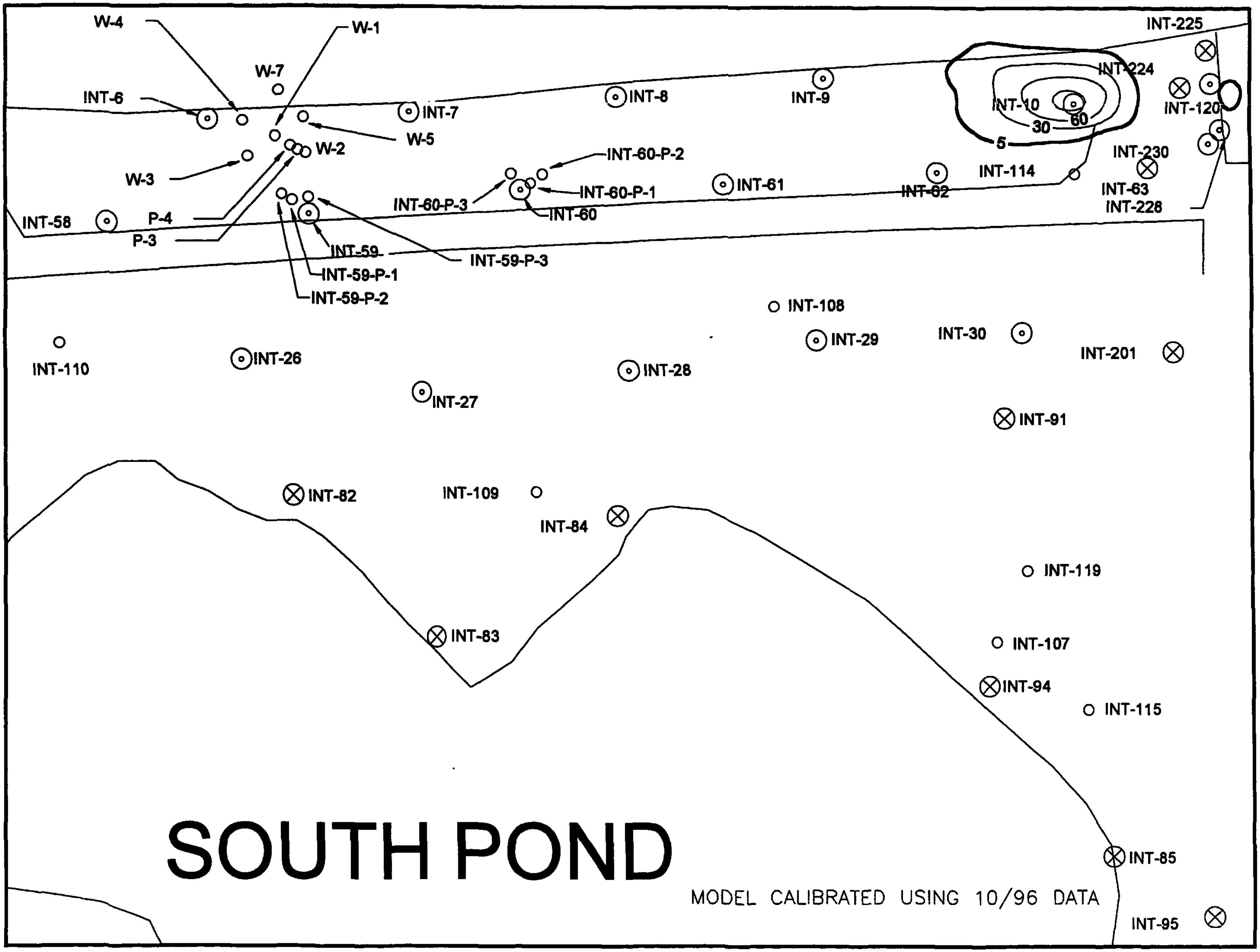
NT CENTRAL DEMONSTR TION: 1,2-DCA (ppb) INITIA



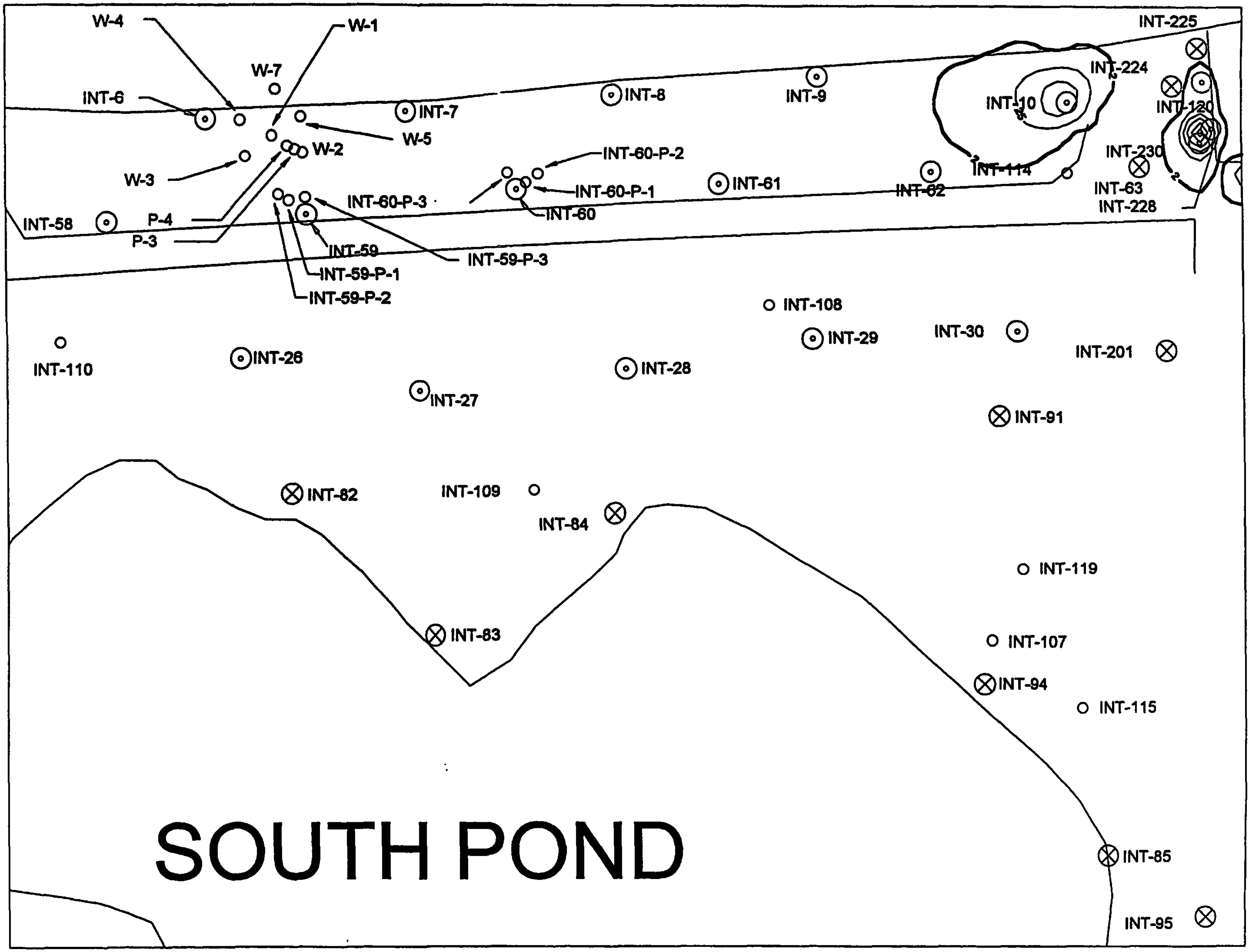
INT CENTRAL HYBRID DEMONSTRATION: 1,2-DCA (ppb) YEAR 1996



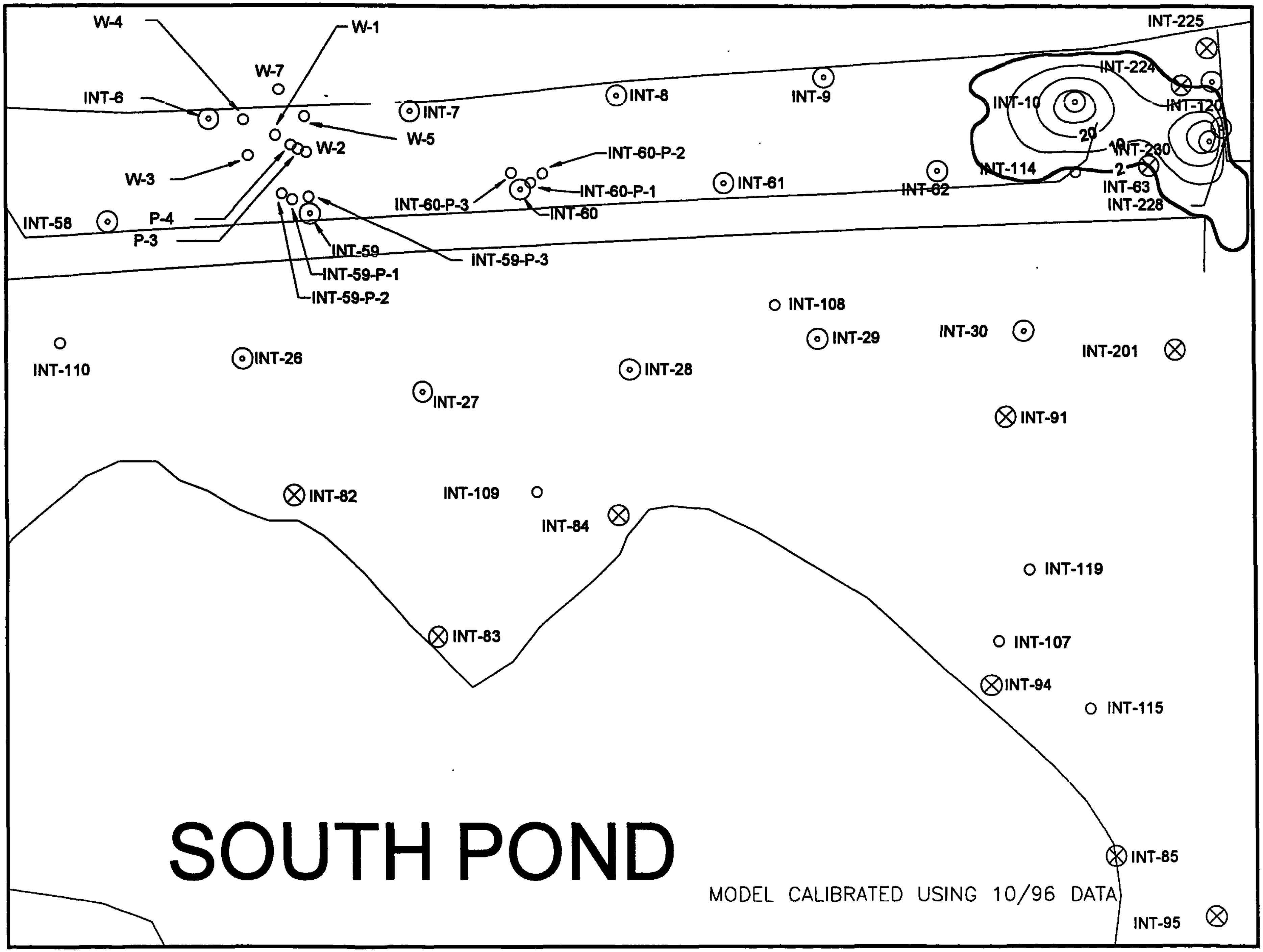
INT CENTRAL DEMONSTRATION: 1,2-DCA (ppb) YEAR 2005



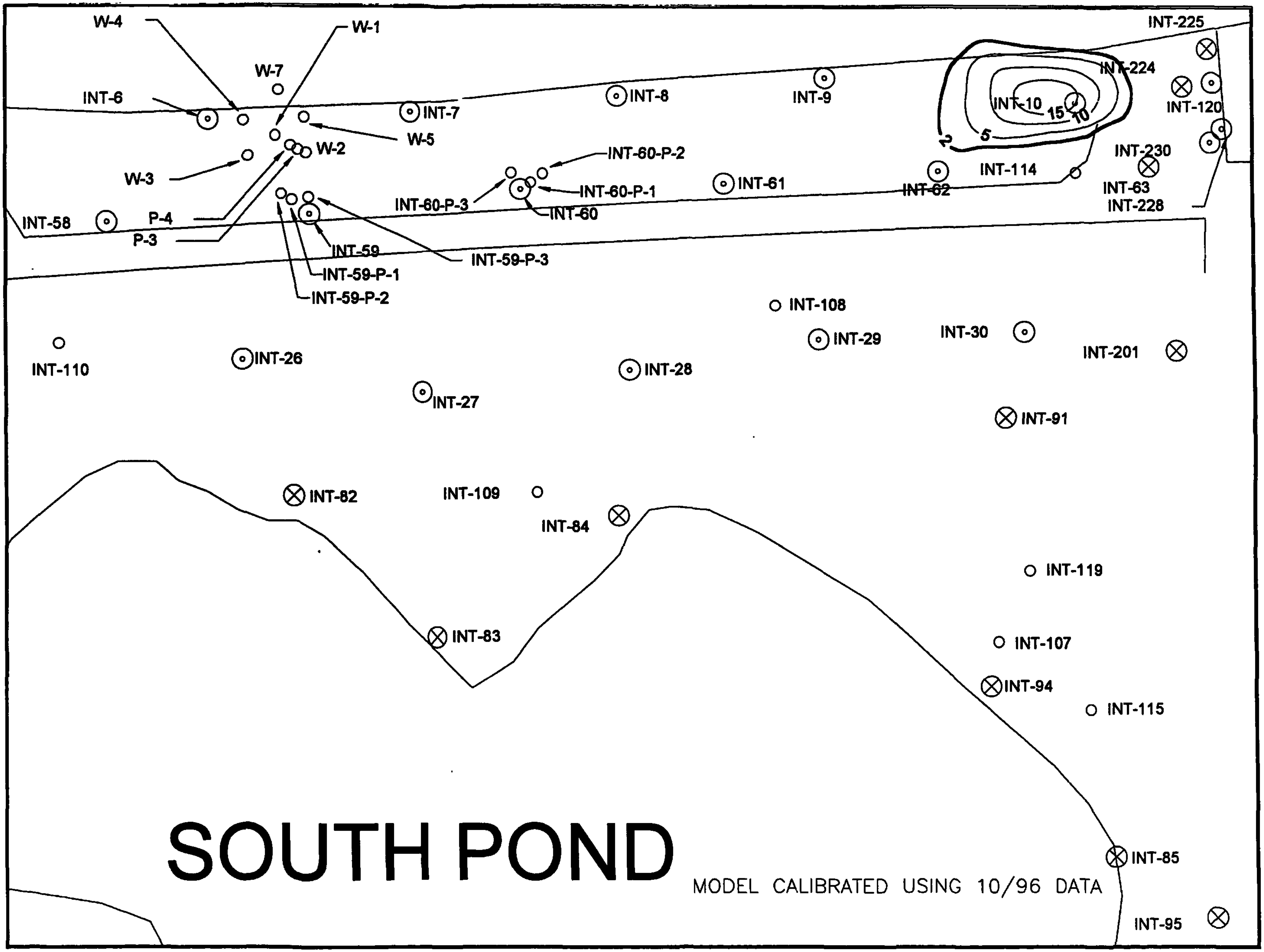
INT ENTRAL DEMONSTRATIO : VINYL CHLORIDE (ppb) II TIAL



INT CENTRAL HYBRID DEMONSTRATION: VINYL CHLORIDE (ppb) YEAR 1996



INT CENTRAL DEMONSTRATION: VINYL CHLORIDE (ppb) YEAR 2005

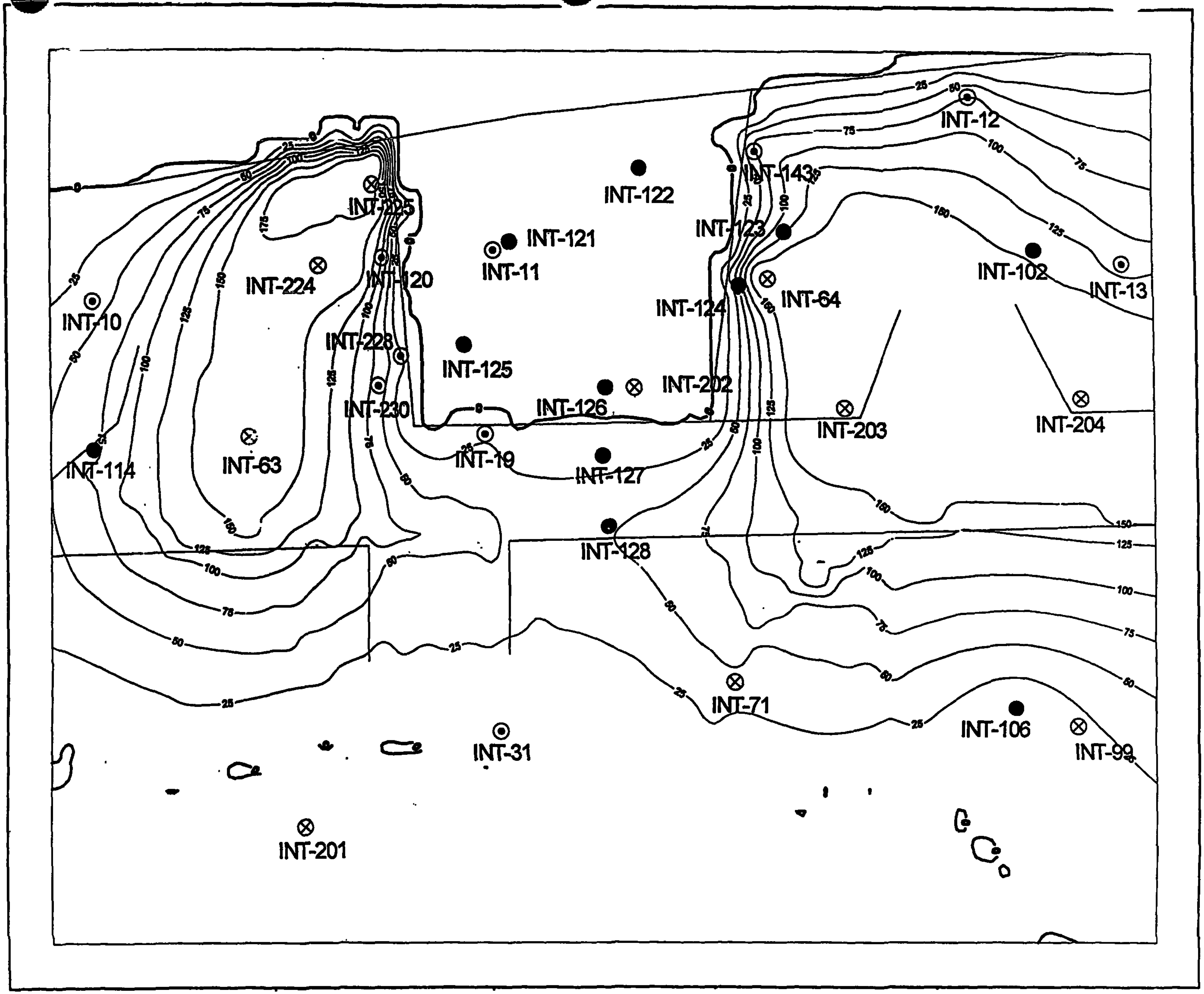


APPENDIX B-3

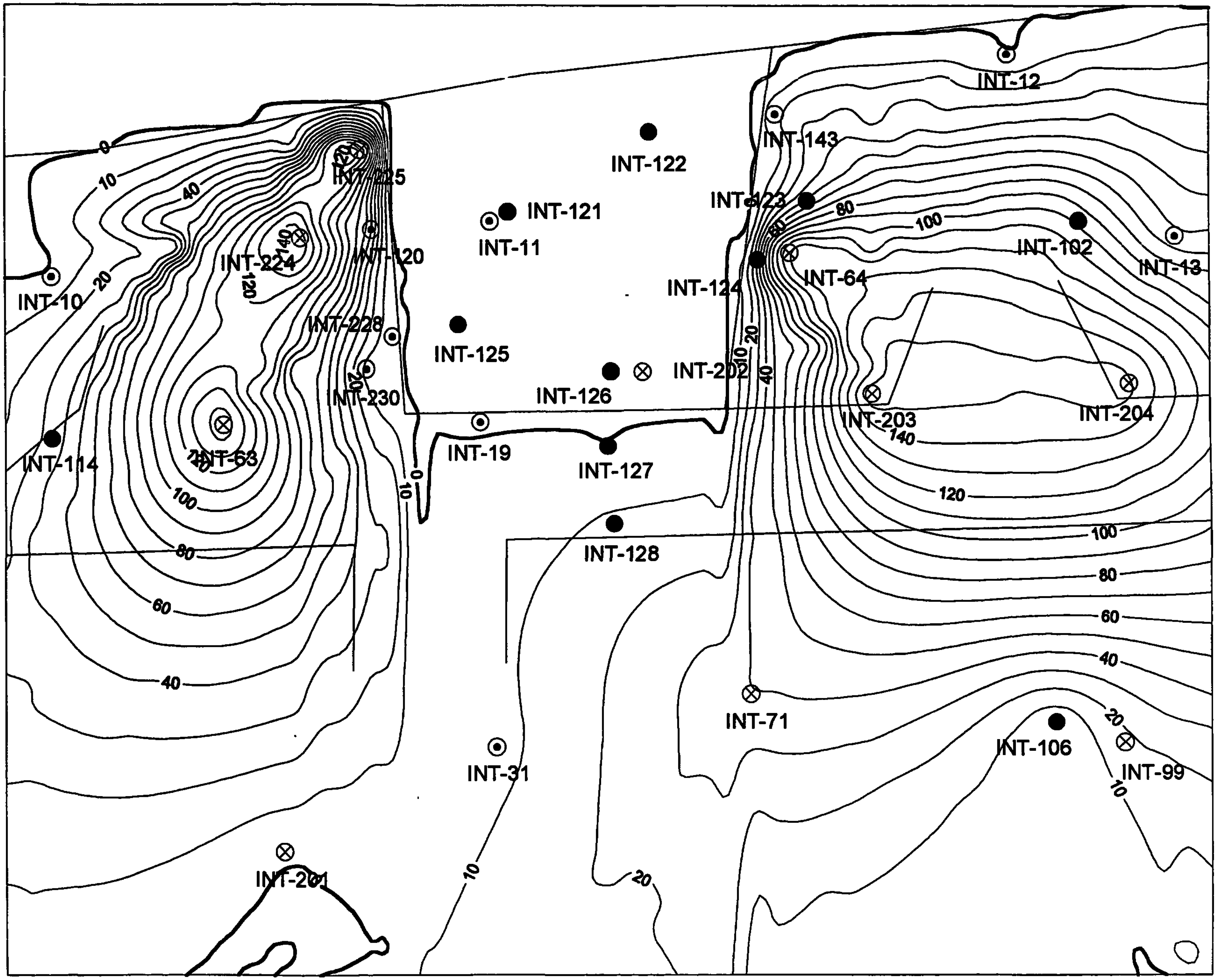
INT-11 wall area

1. DO+ initial
2. DO+ 1996
3. DO+ 2005
4. TOC initial
5. TOC 1996
6. TOC 2005
7. Benzene initial
8. Benzene 1996
9. Benzene 2005
10. 1,2-DCA initial
11. 1,2-DCA 1996
12. 1,2-DCA 2005
13. Vinyl chloride initial
14. Vinyl chloride 1996
15. Vinyl chloride 2005

INT WALL DEMONSTRATION DO+ (ppm) INITIAL

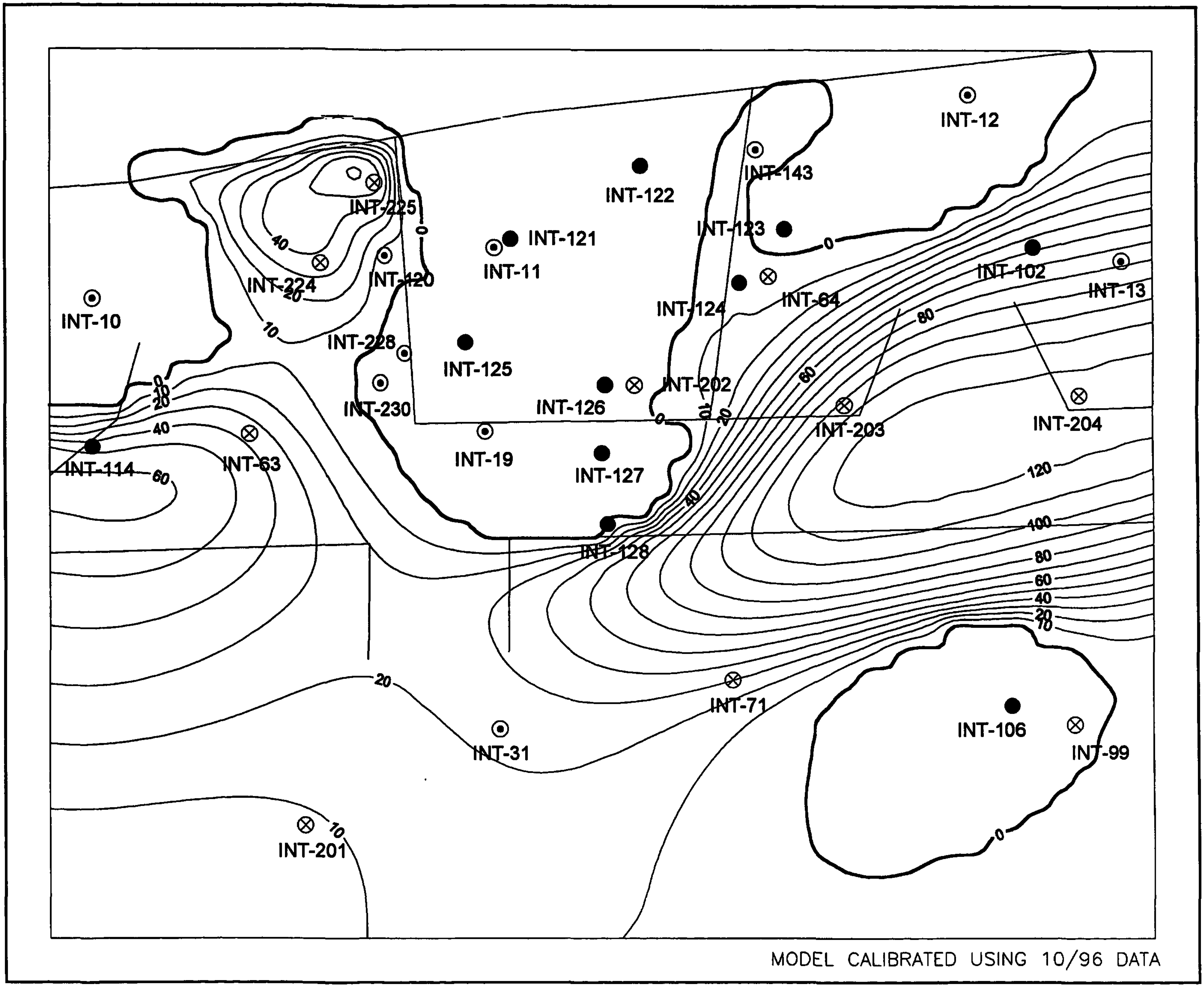


INT WALL HYBRID DEMONSTRATION: DO+ (ppm) YEAR 1996

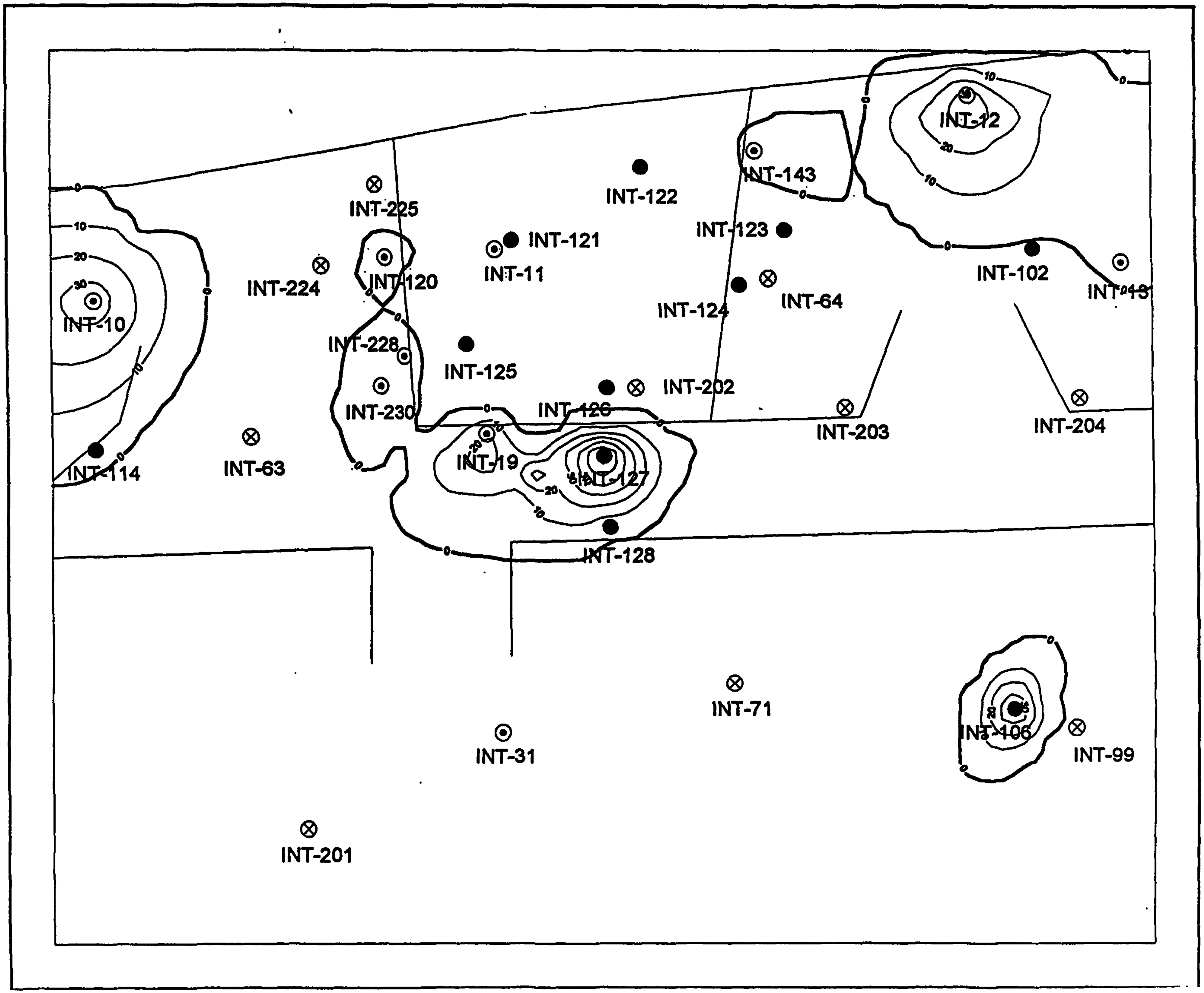


MODEL CALIBRATED USING 10/96 DATA

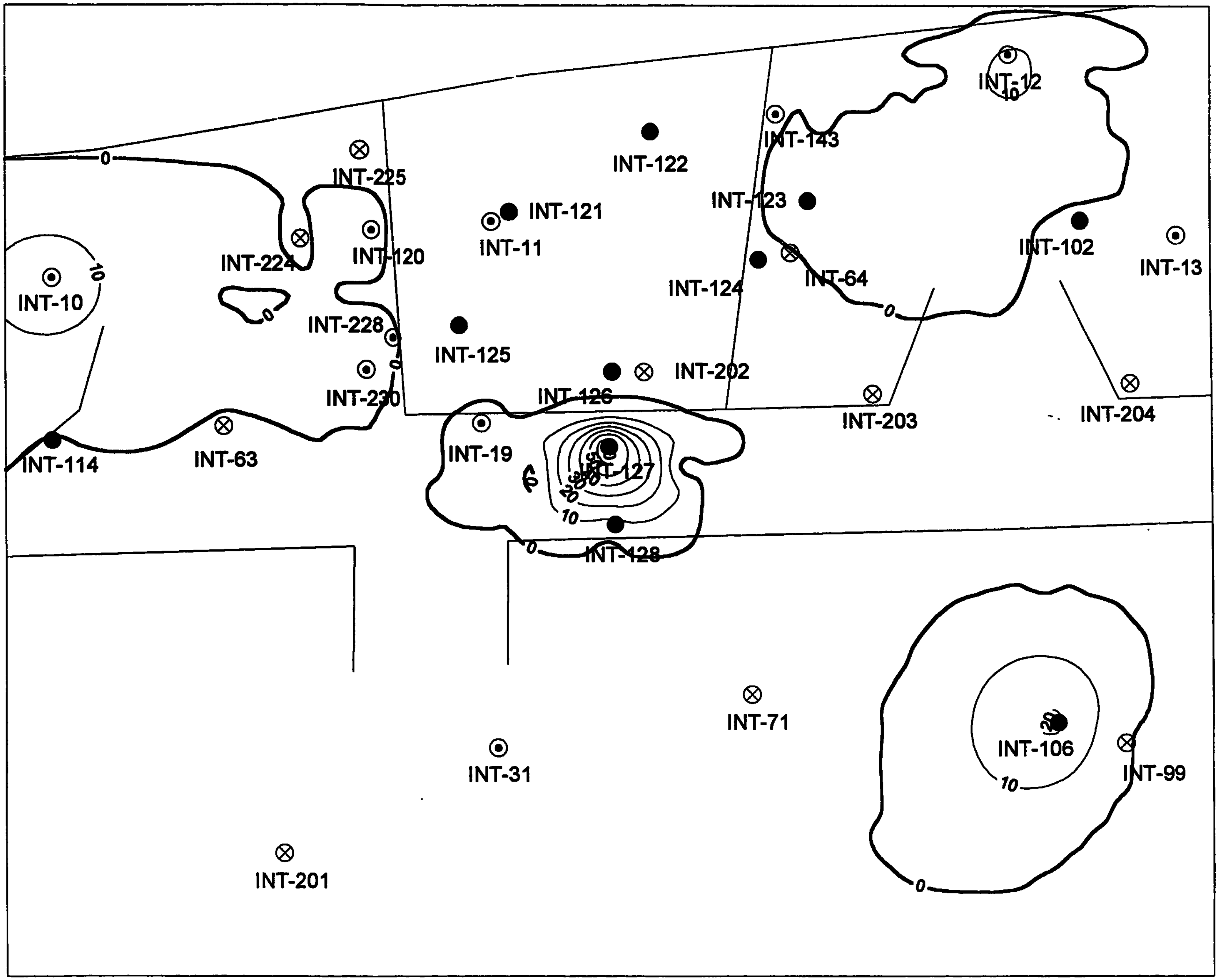
INT WALL DEMONSTRATION: DO+ (ppm) YEAR 2005



INT WALL DEMONSTR ION: TOC (ppm) INITIAL

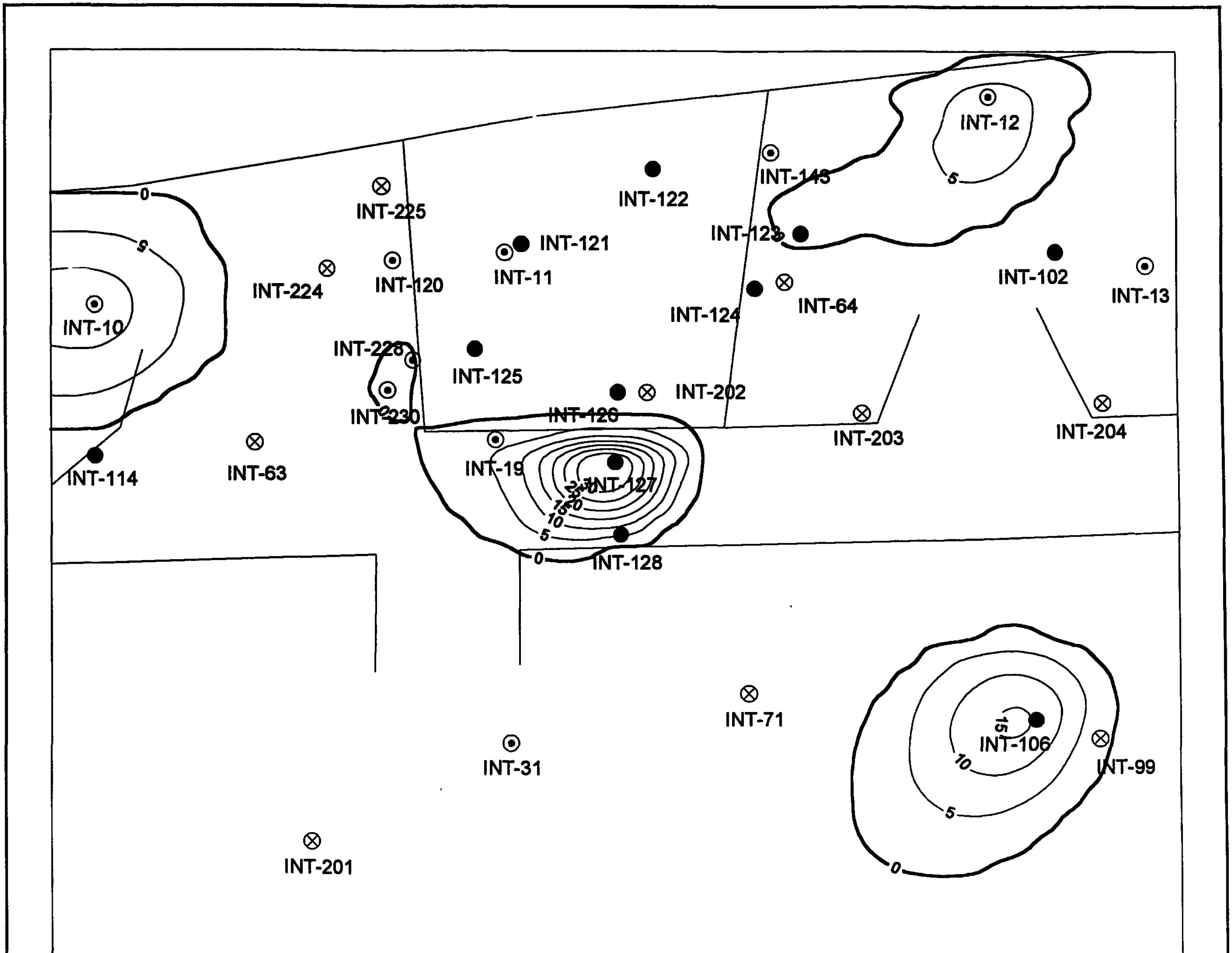


INT WALL HYBRID DEMONSTRATION: TOC (ppm) YEAR 1996



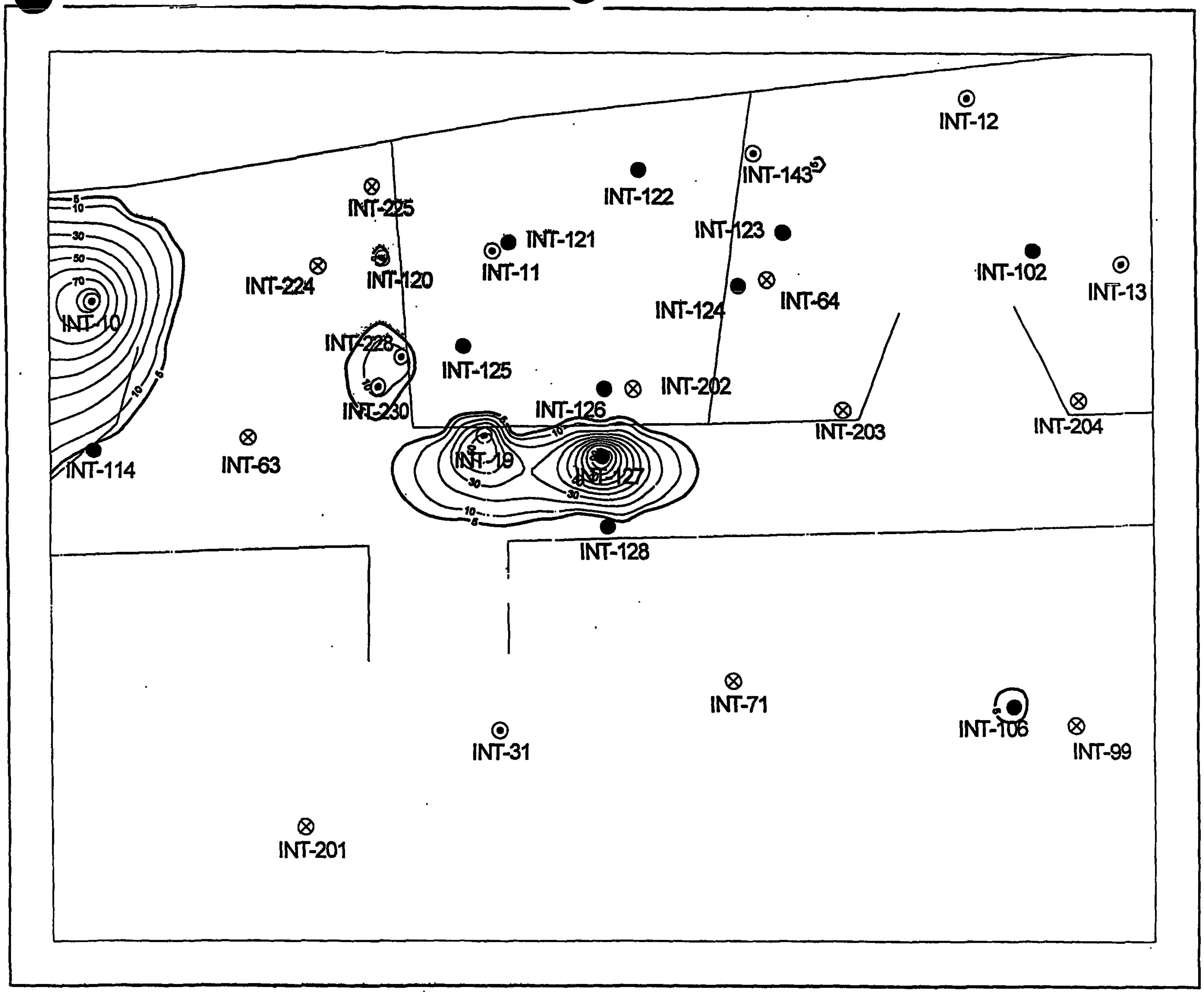
MODEL CALIBRATED USING 10/96 DATA

INT WALL DEMONSTRATI[obscured]: TOC (ppm) YEAR 2005

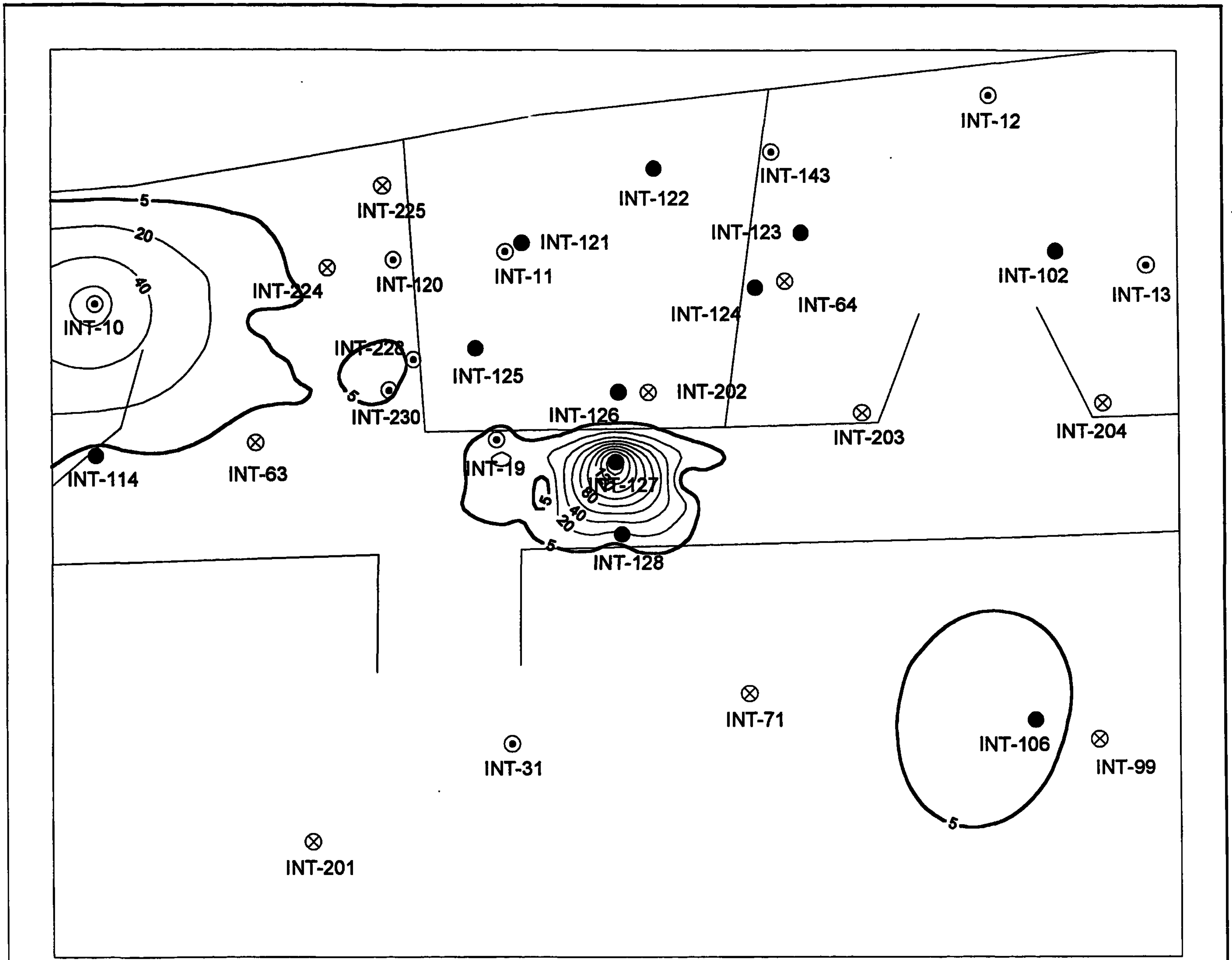


MODEL CALIBRATED USING 10/96 DATA

IN-I WALL DEMONSTRATION: BENZENE (ppb) INITIAL

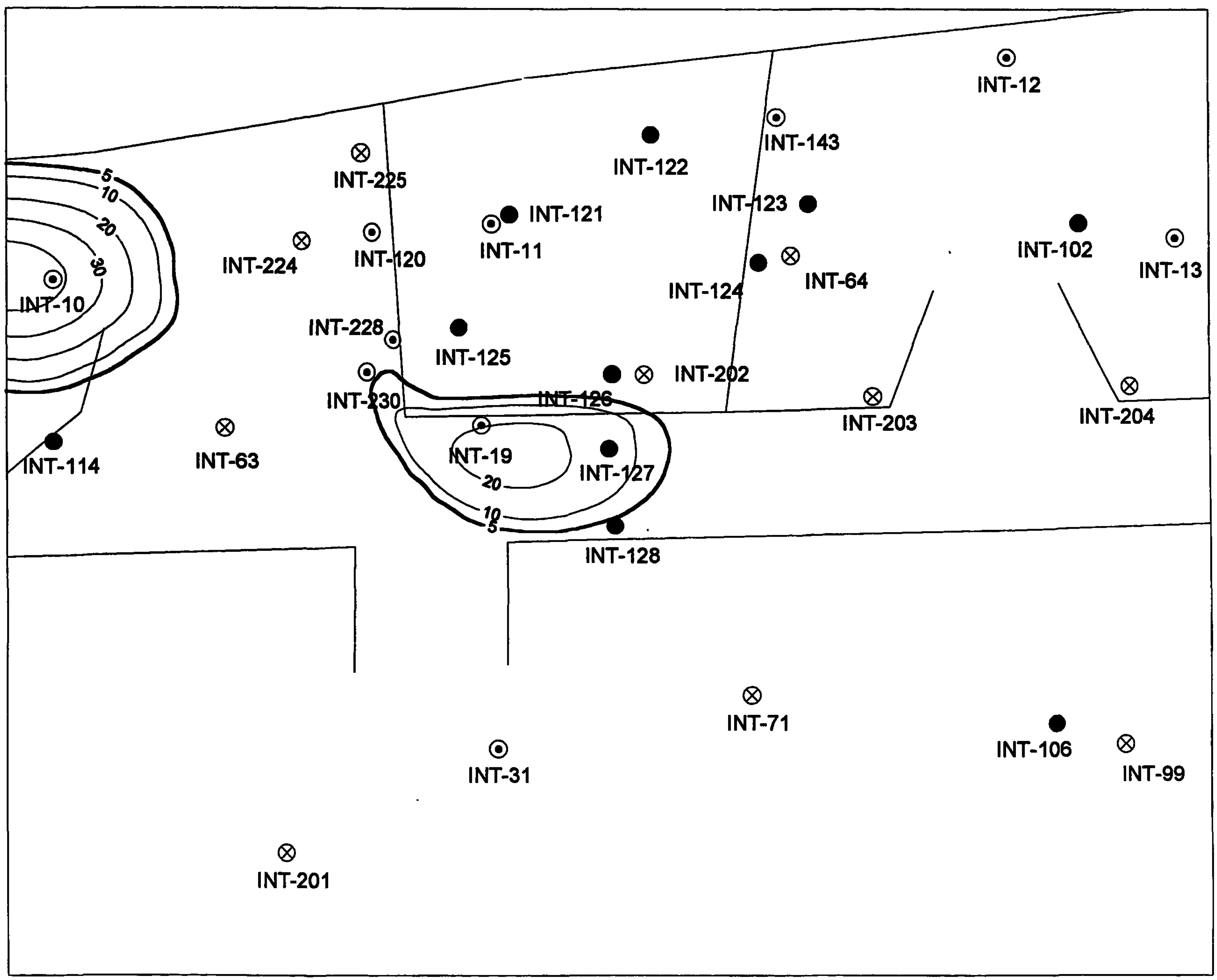


INT WALL HYBRID DEMONSTRATION: BENZENE (ppb) YEAR 1996



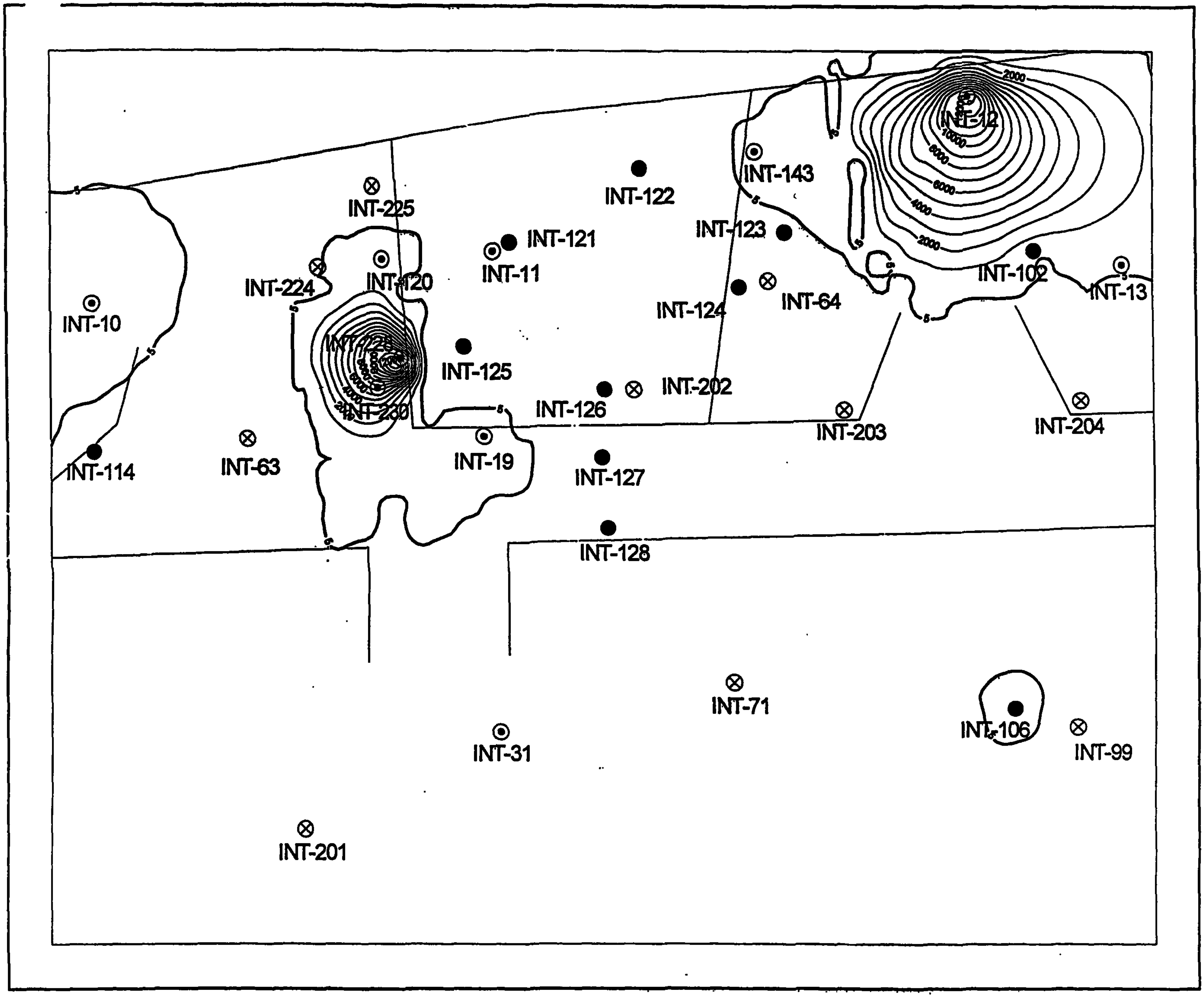
MODEL CALIBRATED USING 10/96 DATA

INT WALL DEMONSTRATION - BENZENE (ppb) YEAR 2005

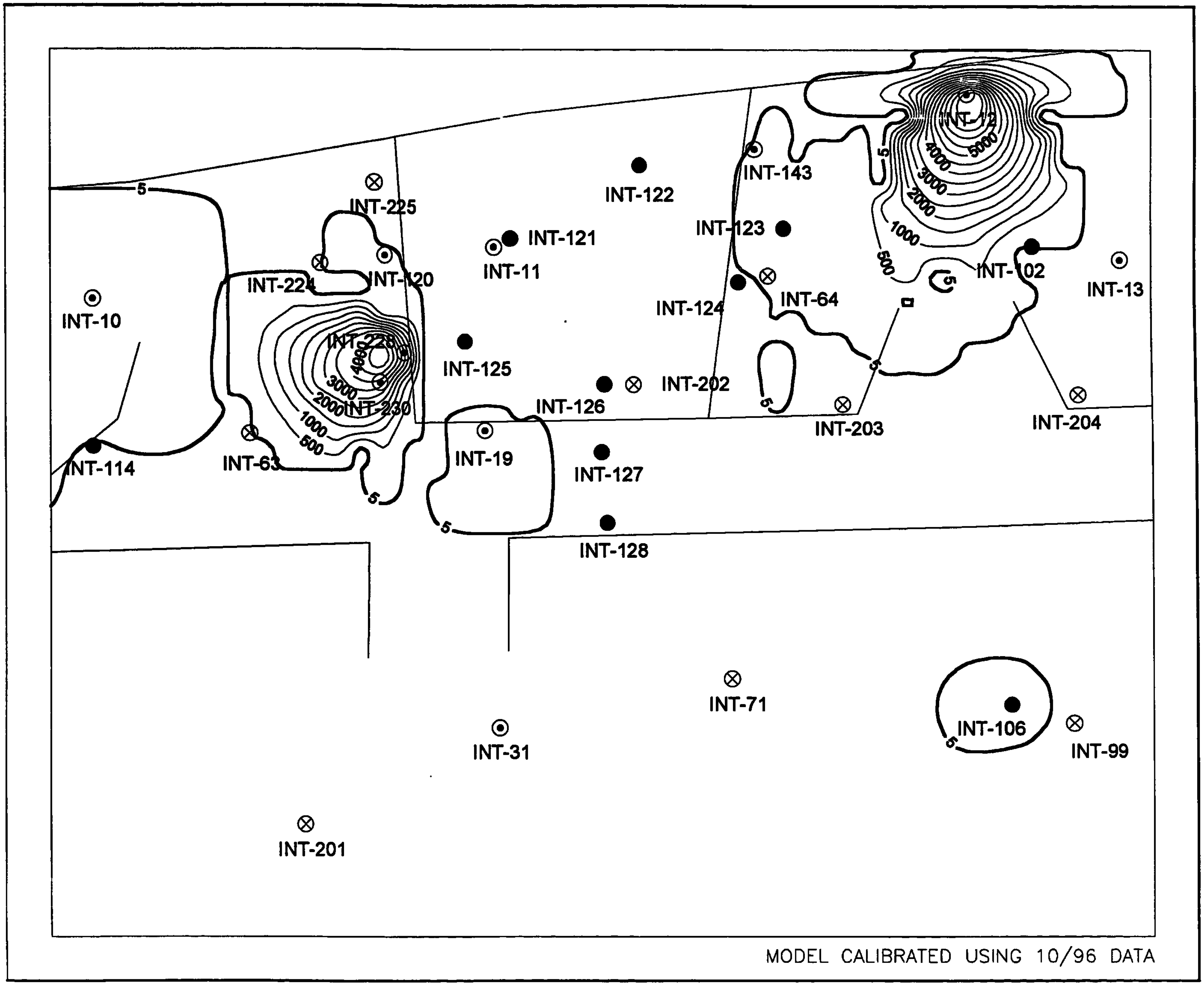


MODEL CALIBRATED USING 10/96 DATA

INT WALL DEMONSTRATION: 1,2 DCA (ppb) INITIAL

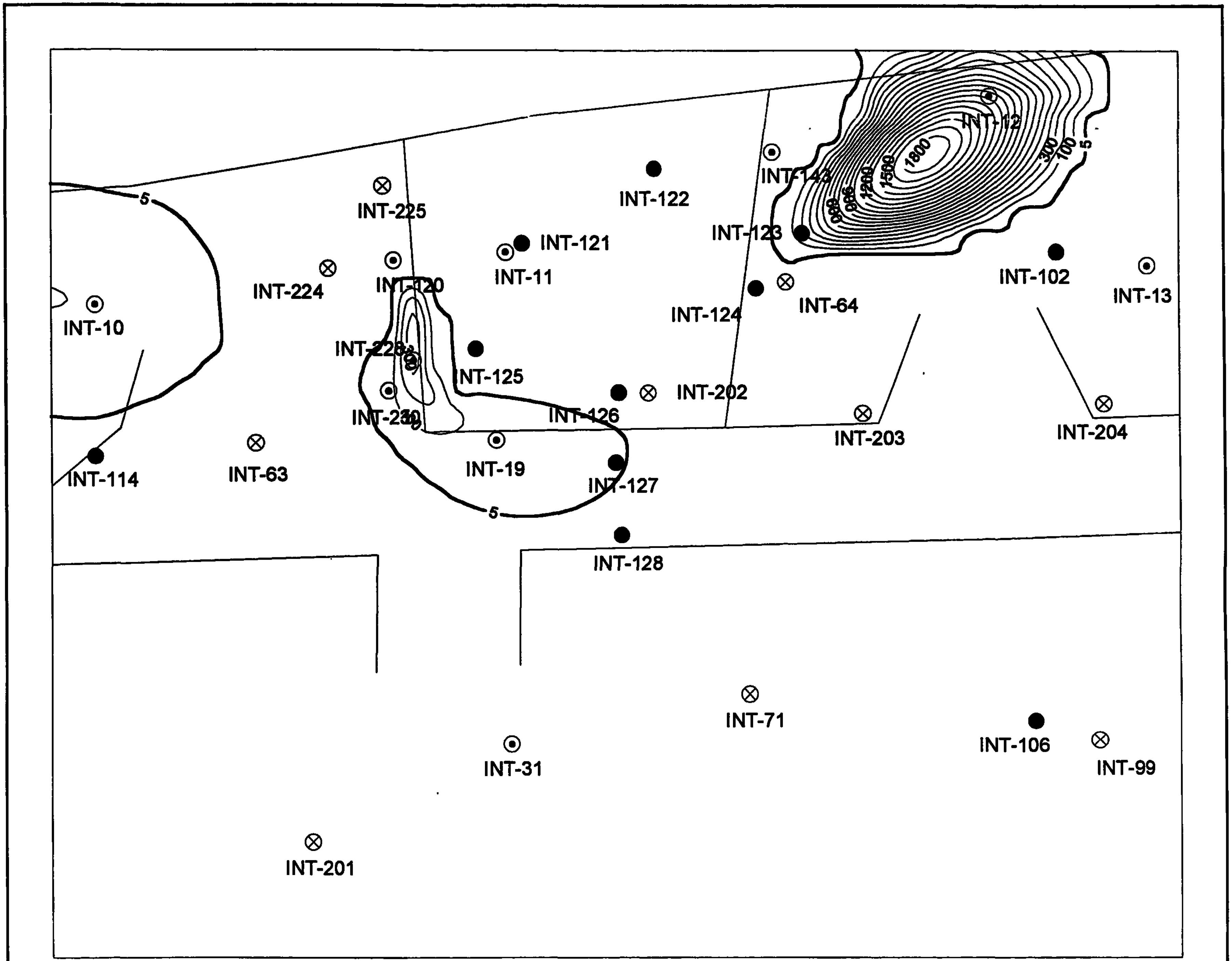


INT WALL HYBRID DEMONSTRATION: 1,2-DCA (ppb) YEAR 1996



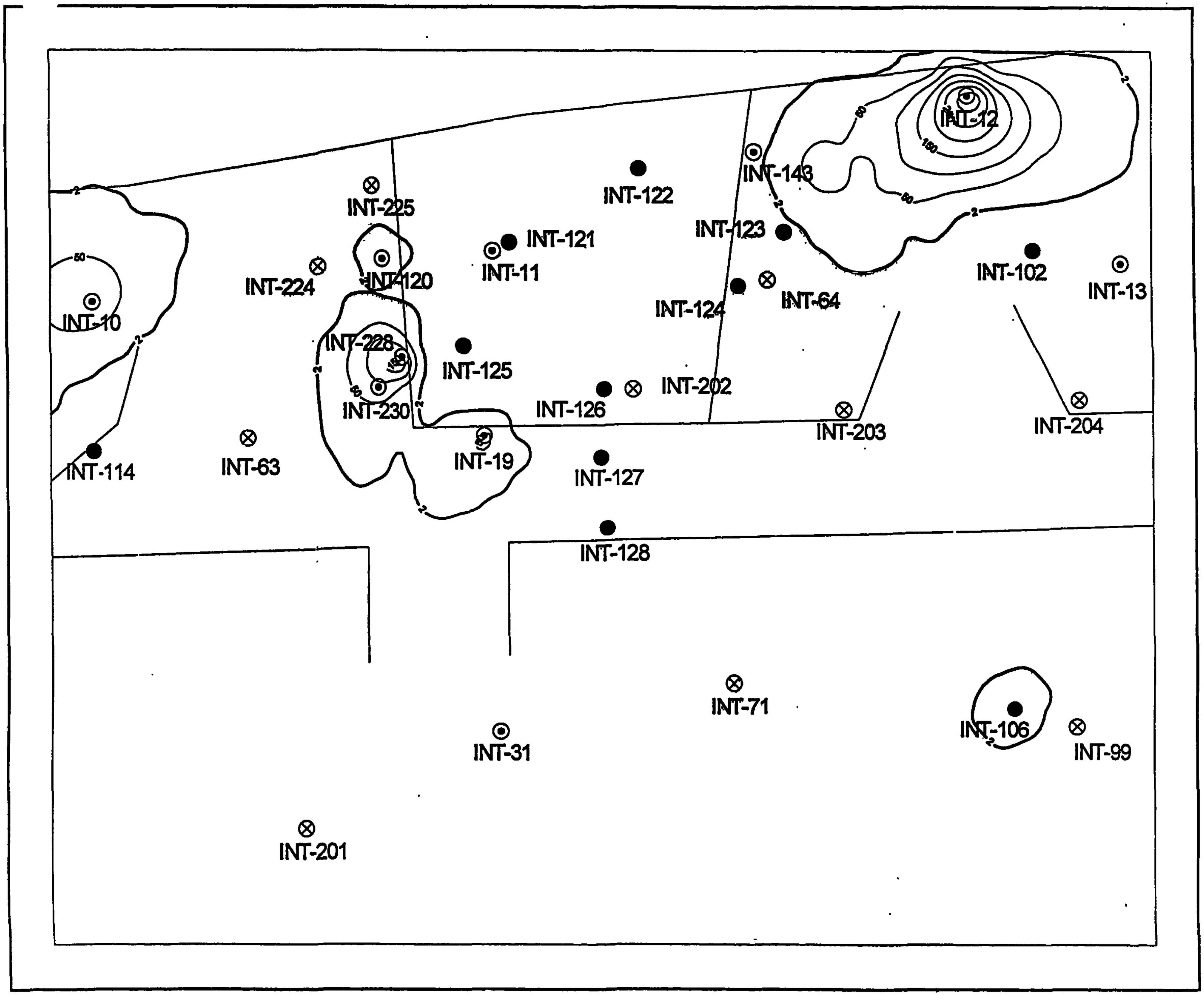
MODEL CALIBRATED USING 10/96 DATA

INT WALL DEMONSTRATIO[N] 1,2-DCA (ppb) YEAR 2005

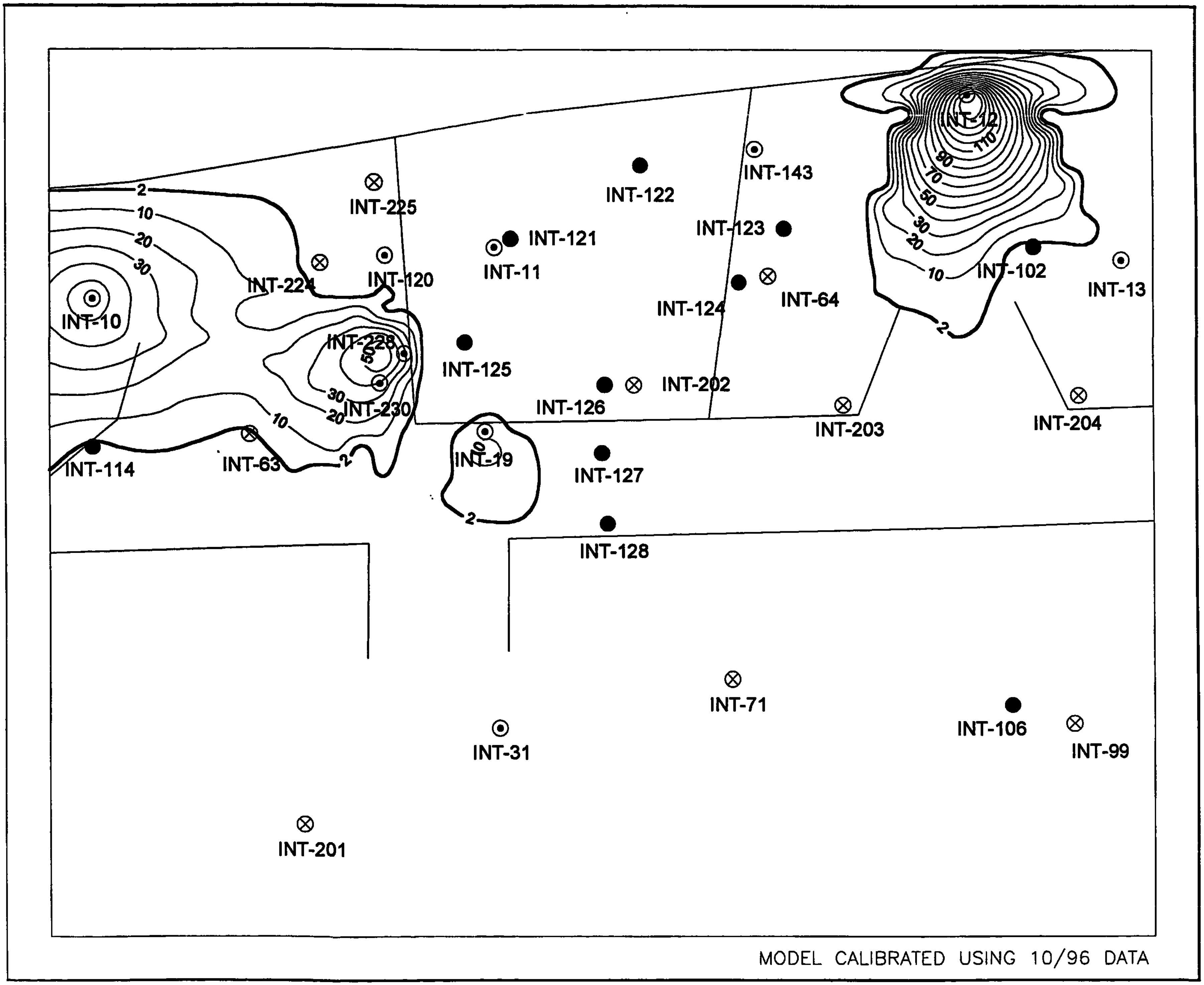


MODEL CALIBRATED USING 10/96 DATA

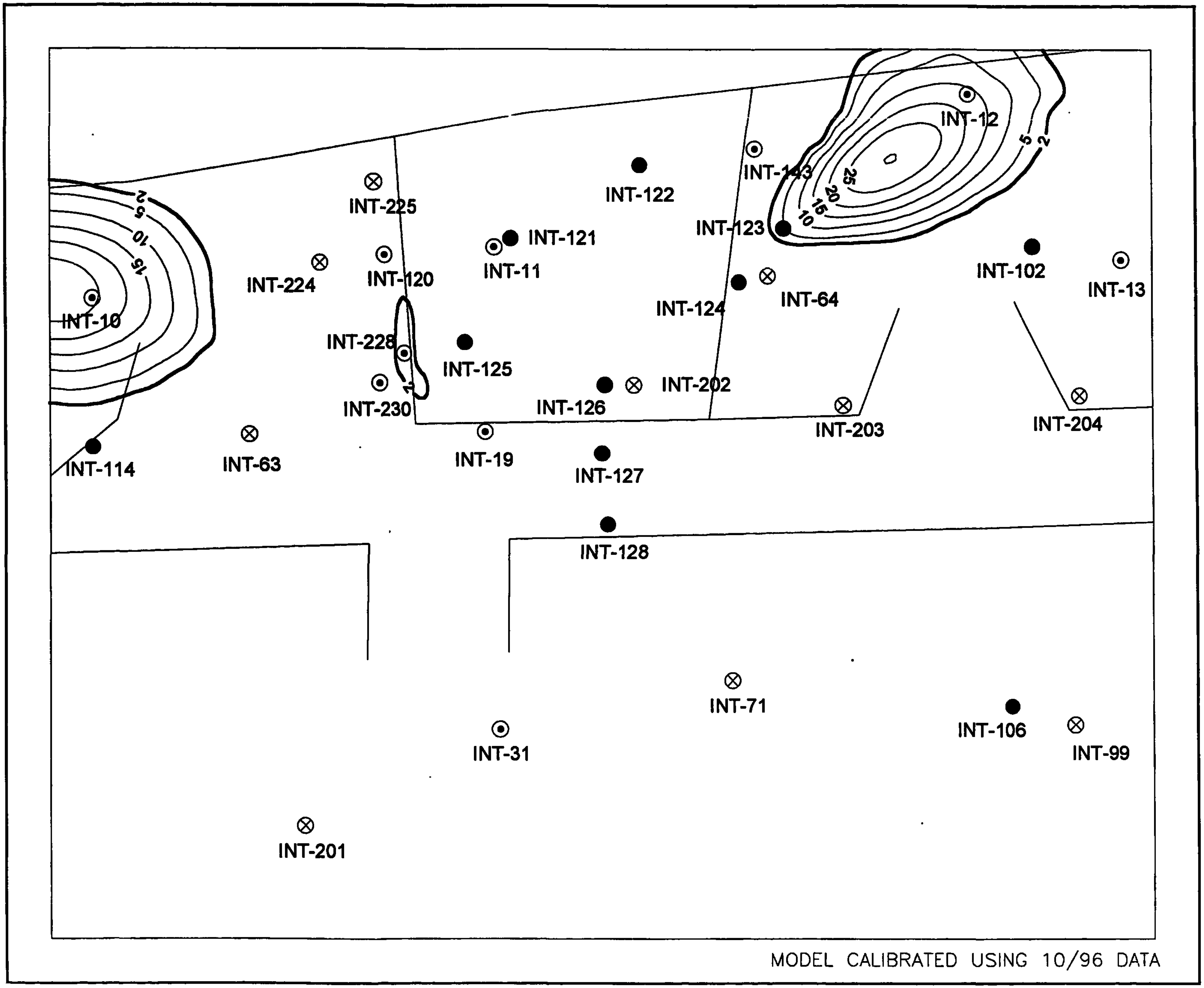
INT WALL DEMONSTRATION: VINYL CHLORIDE (ppb) INITIAL



INT WALL HYBRID DEMONSTRATION VINYL CHLORIDE (ppb) YEAR 1996



INT WALL DEMONSTRATION: V[illegible]YL CHLORIDE (ppb) YEAR 2005

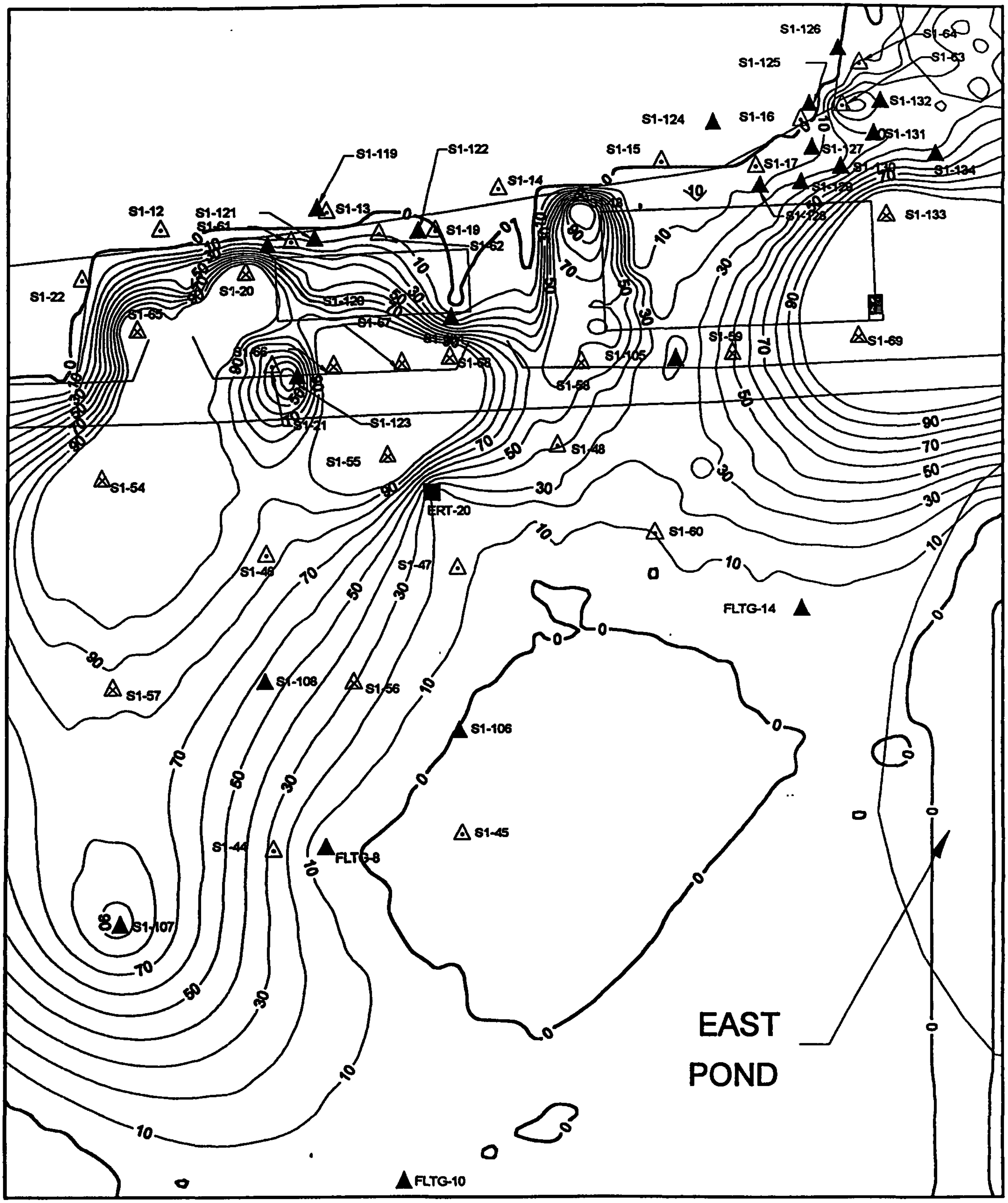


APPENDIX B-4

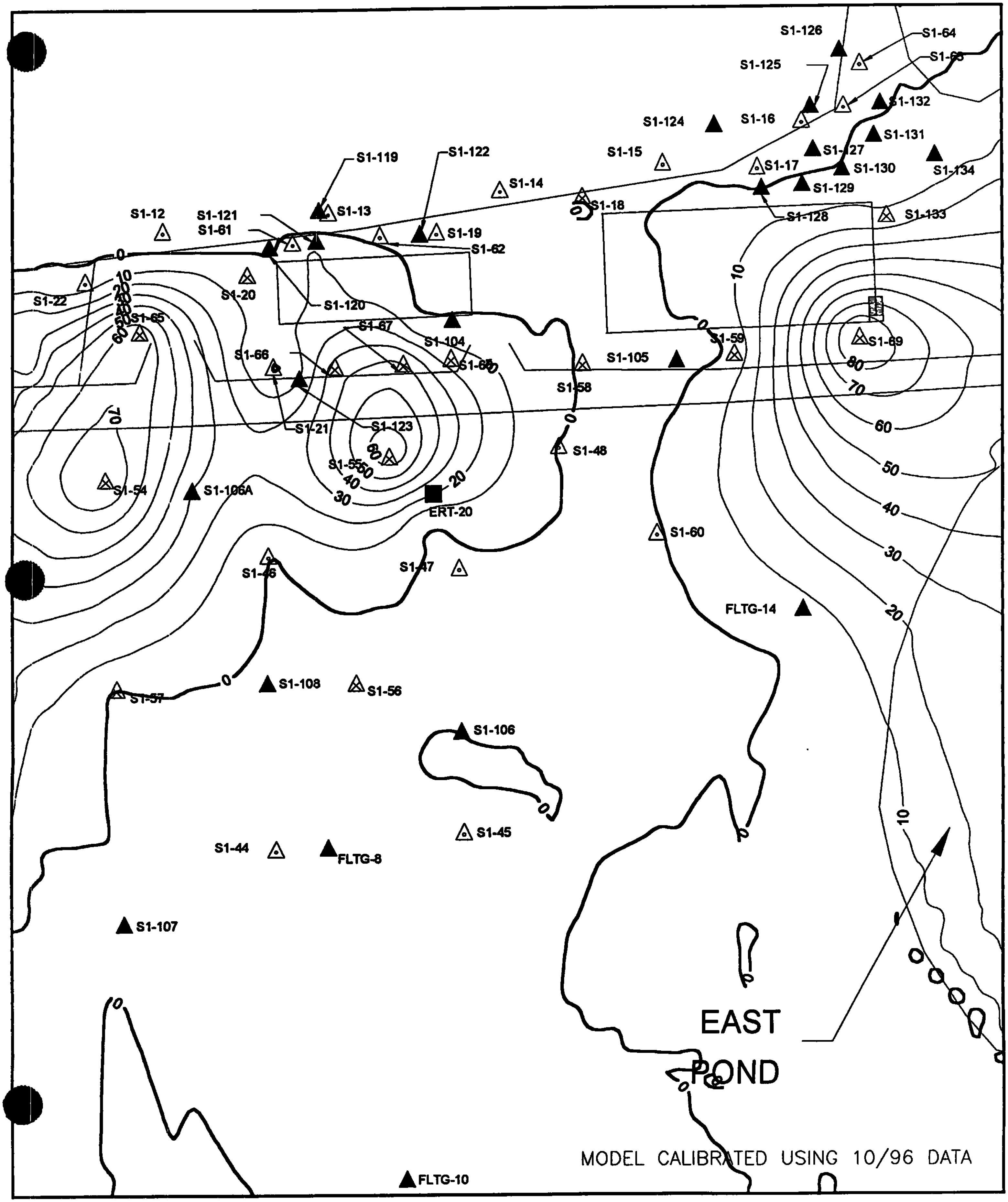
S1 east area

1. DO+ initial
2. DO+ 1996
3. DO+ 2005
4. TOC initial
5. TOC 1996
6. TOC 2005
7. Benzene initial
8. Benzene 1996
9. Benzene 2005
10. 1,2-DCA initial
11. 1,2-DCA 1996
12. 1,2-DCA 2005
13. Vinyl chloride initial
14. Vinyl chloride 1996
15. Vinyl chloride 2005

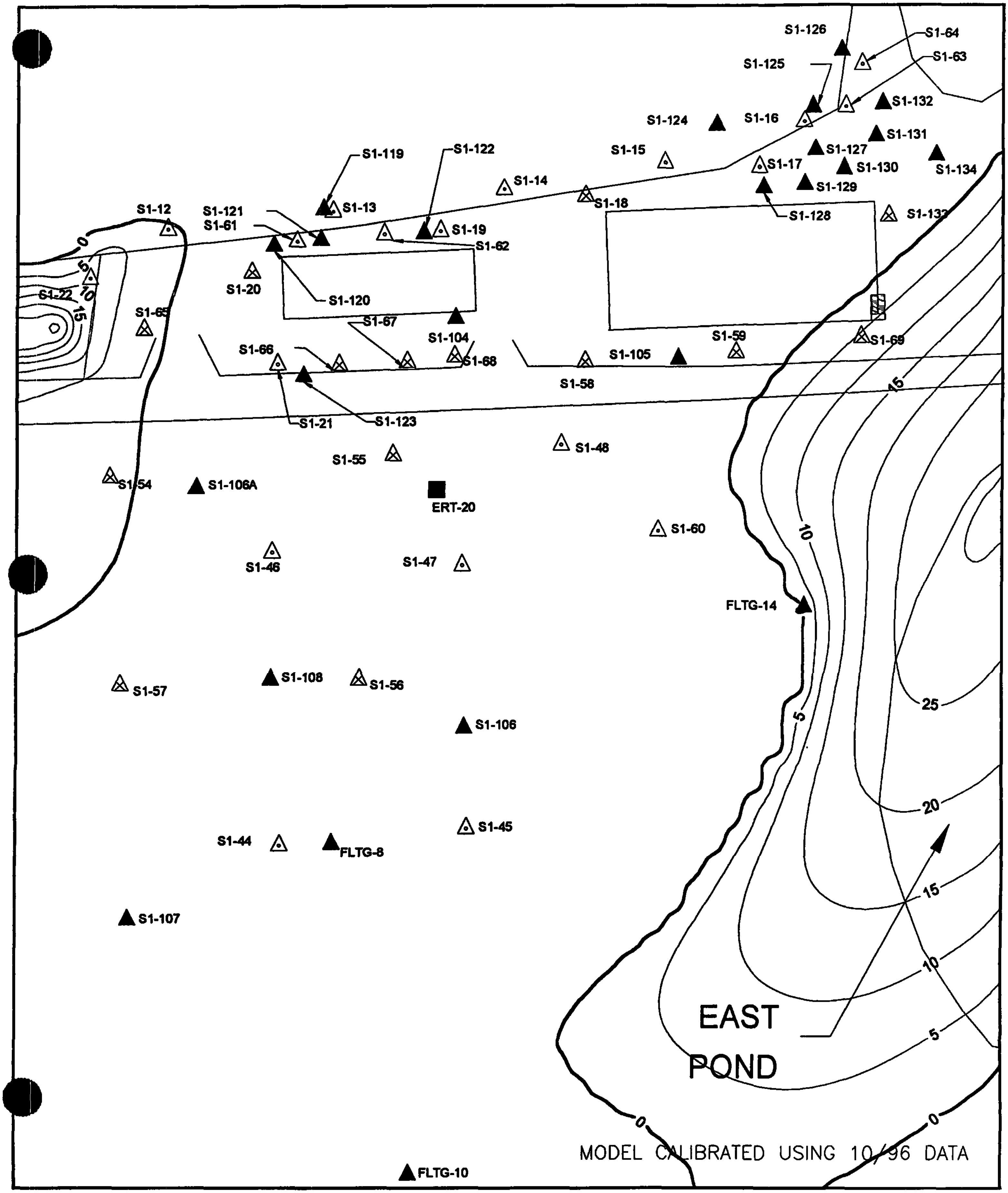
S1 EAST: DO+ (ppm) INITIAL



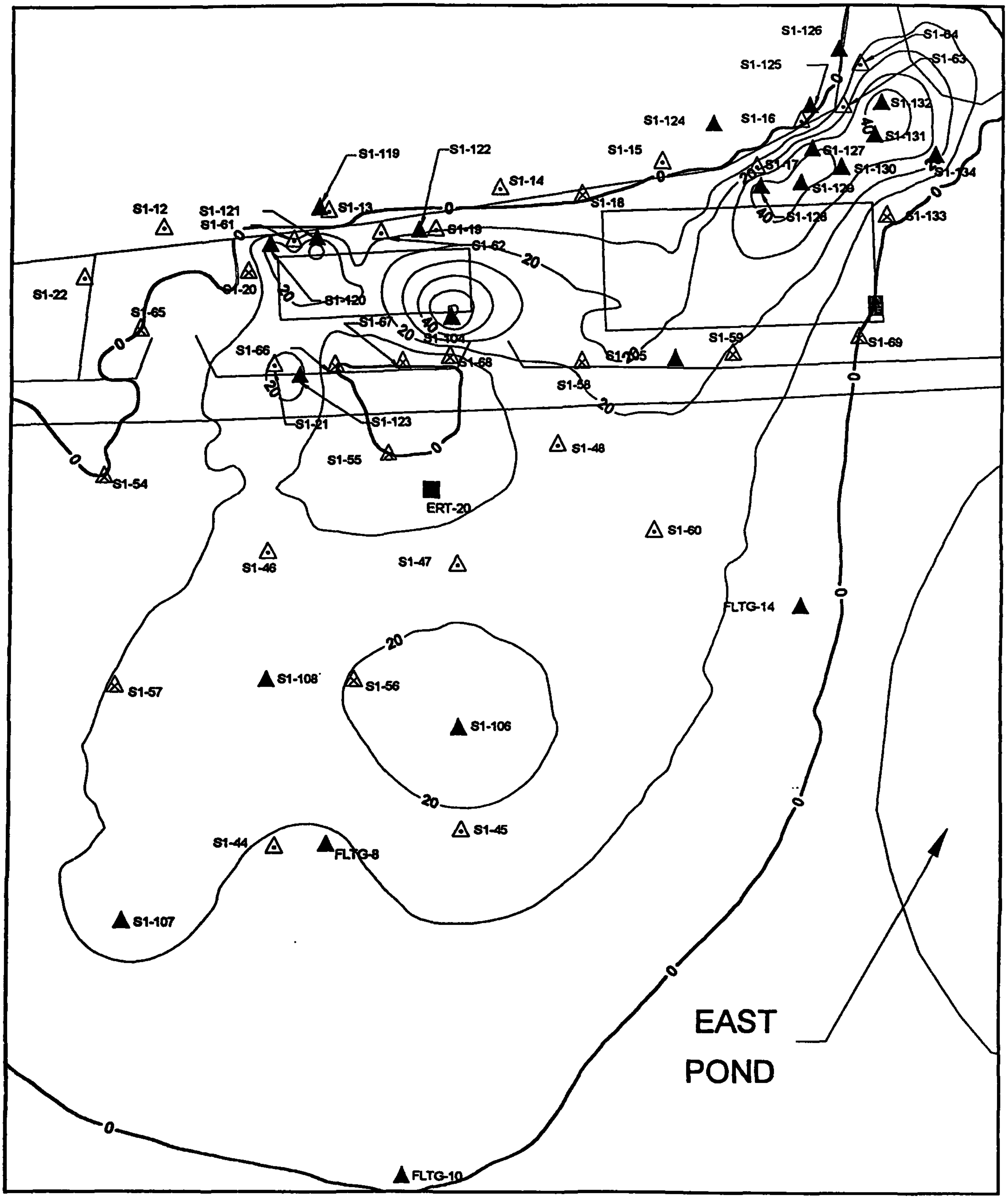
S1 EAST HYBRID DEMONSTRATION: DO+ (ppm) YEAR 1996



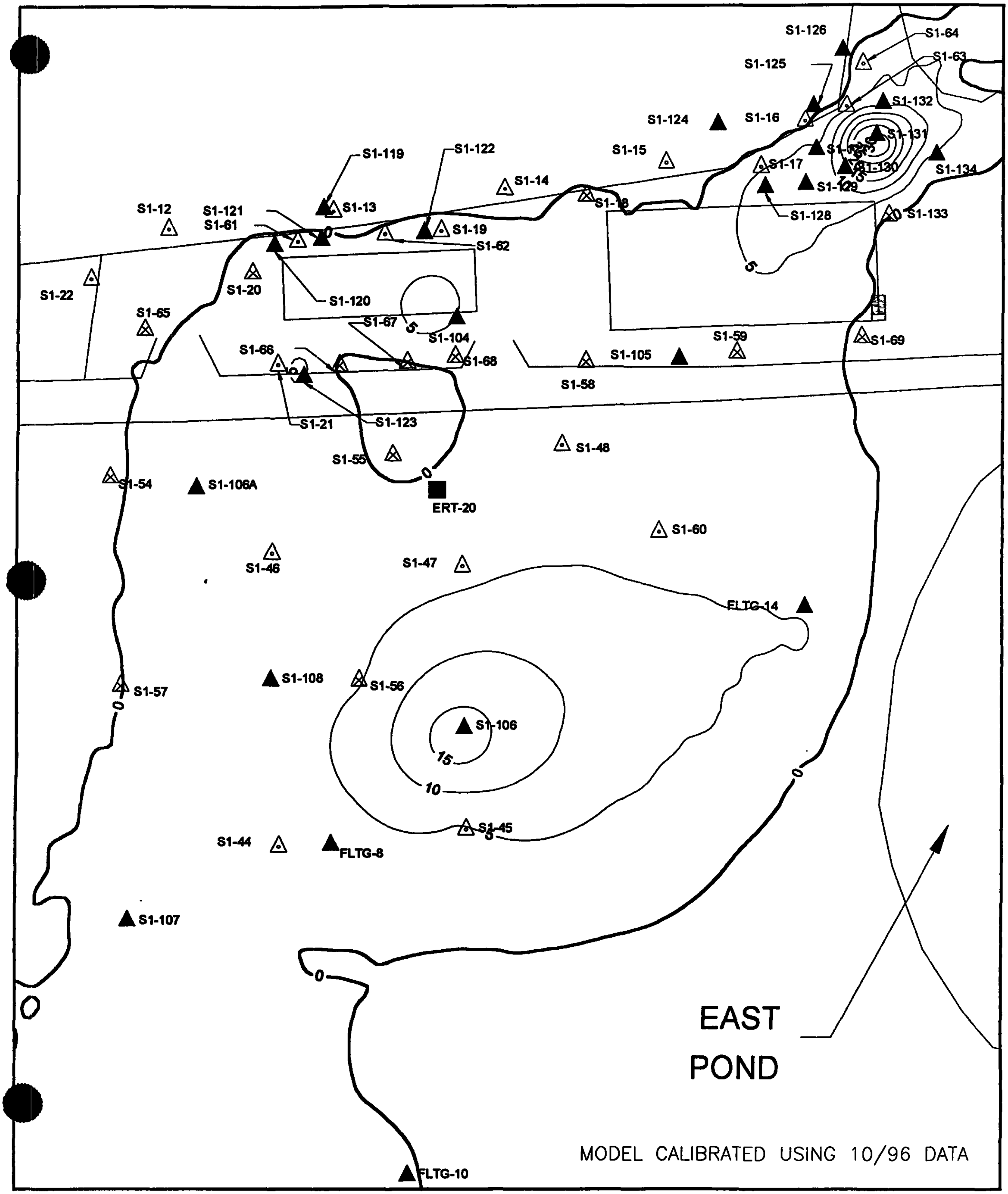
S1 EAST DEMONSTRATION: DO+ (ppm) YEAR 2005



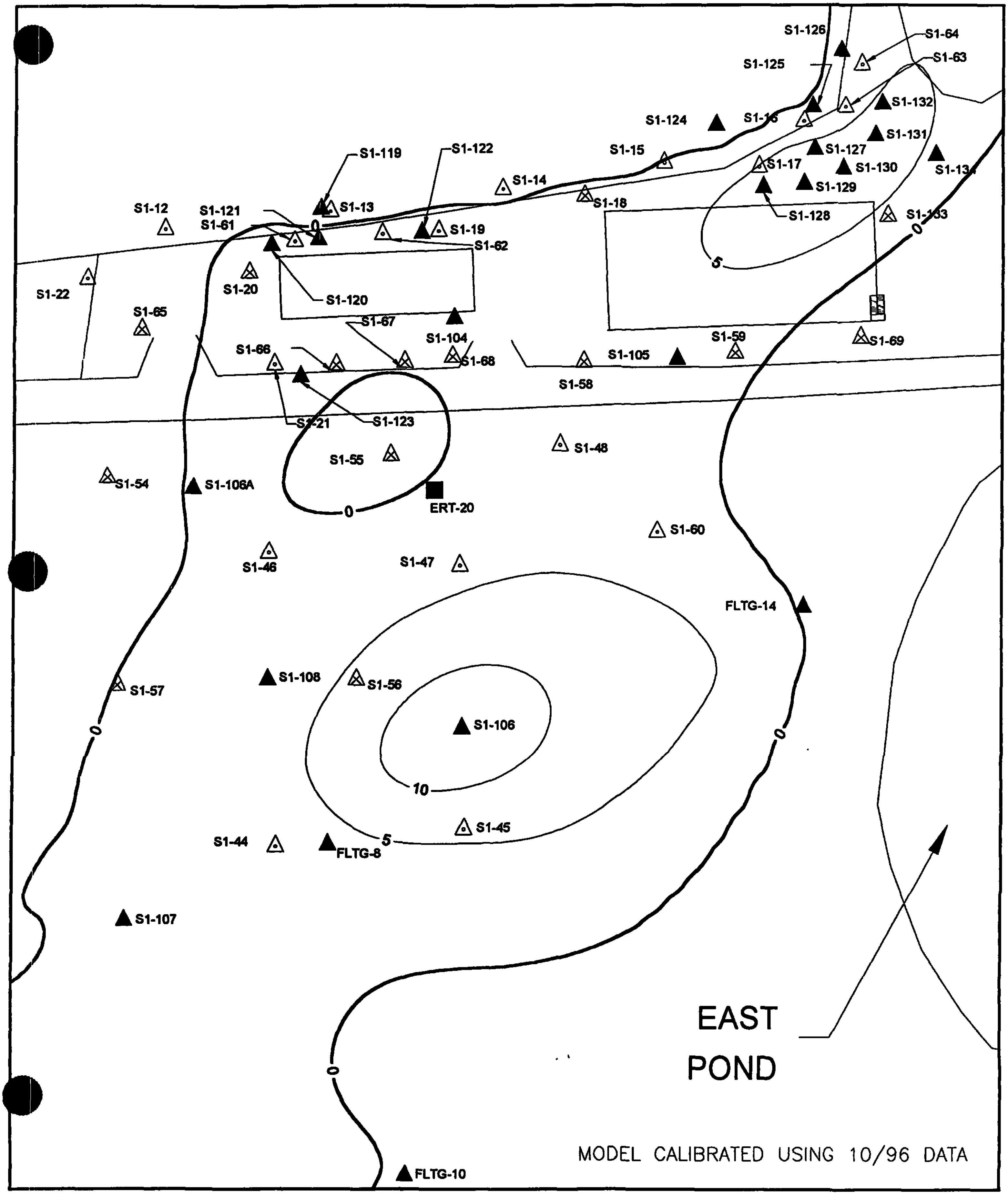
S1 EAST: TOC (ppm) INITIAL



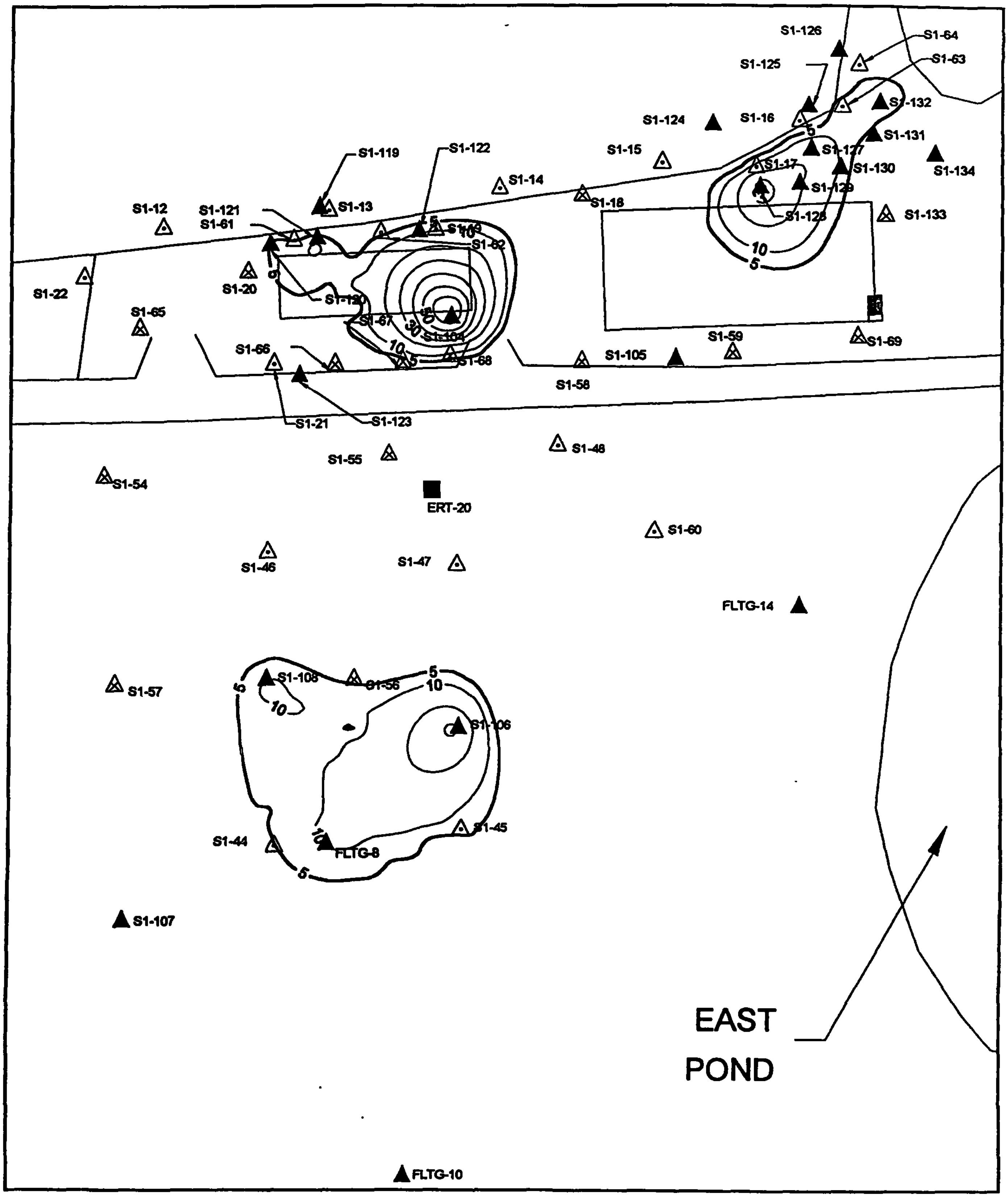
S1 EAST HYBRID DEMONSTRATION: TOC (ppm) YEAR 1996



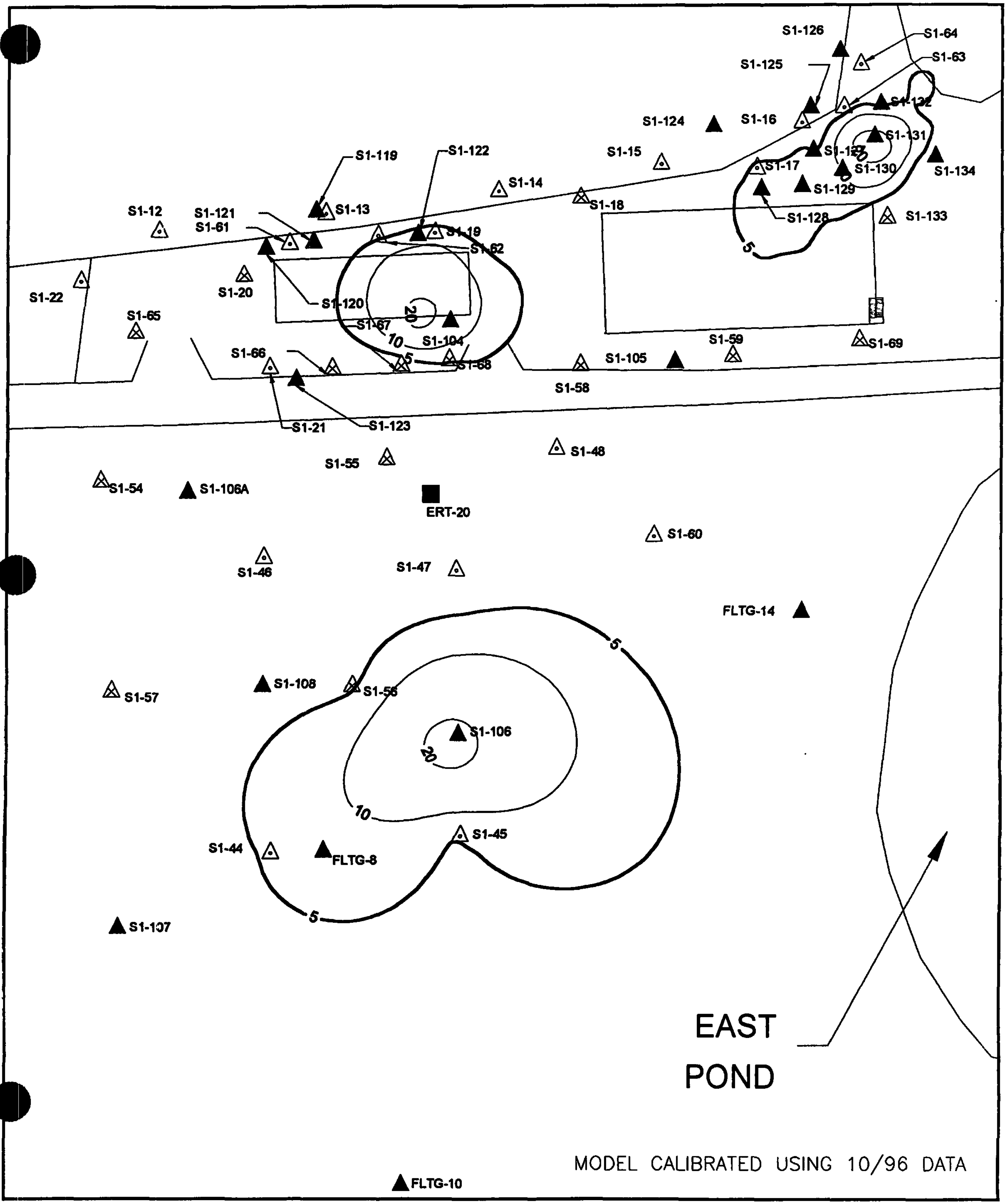
S1 EAST DEMONSTRATION: TOC (ppm) YEAR 2005



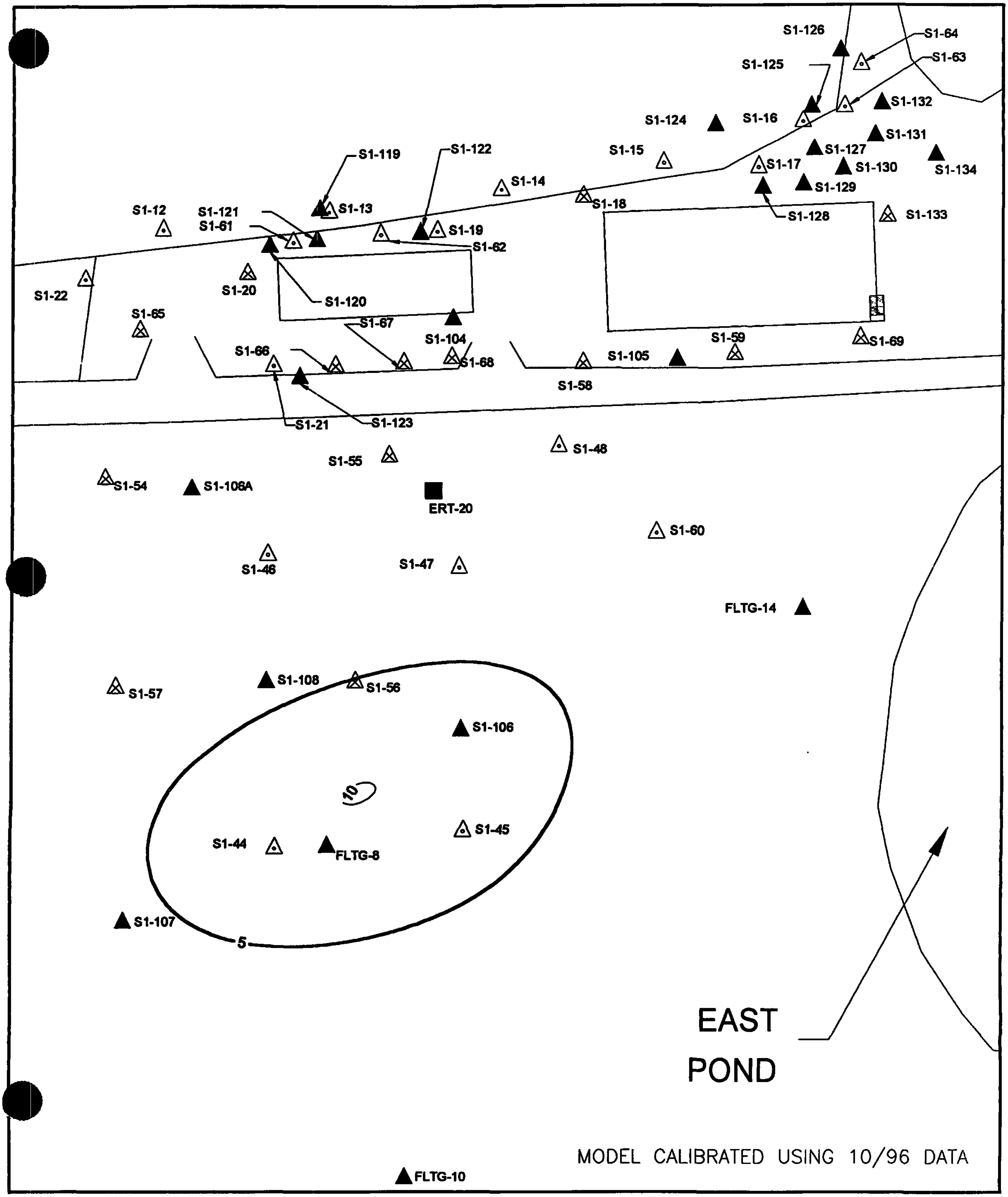
S1 EAST: BENZENE (ppb) INITIAL



S1 EAST HYBRID DEMONSTRATION: BENZENE (ppb) YEAR 1996

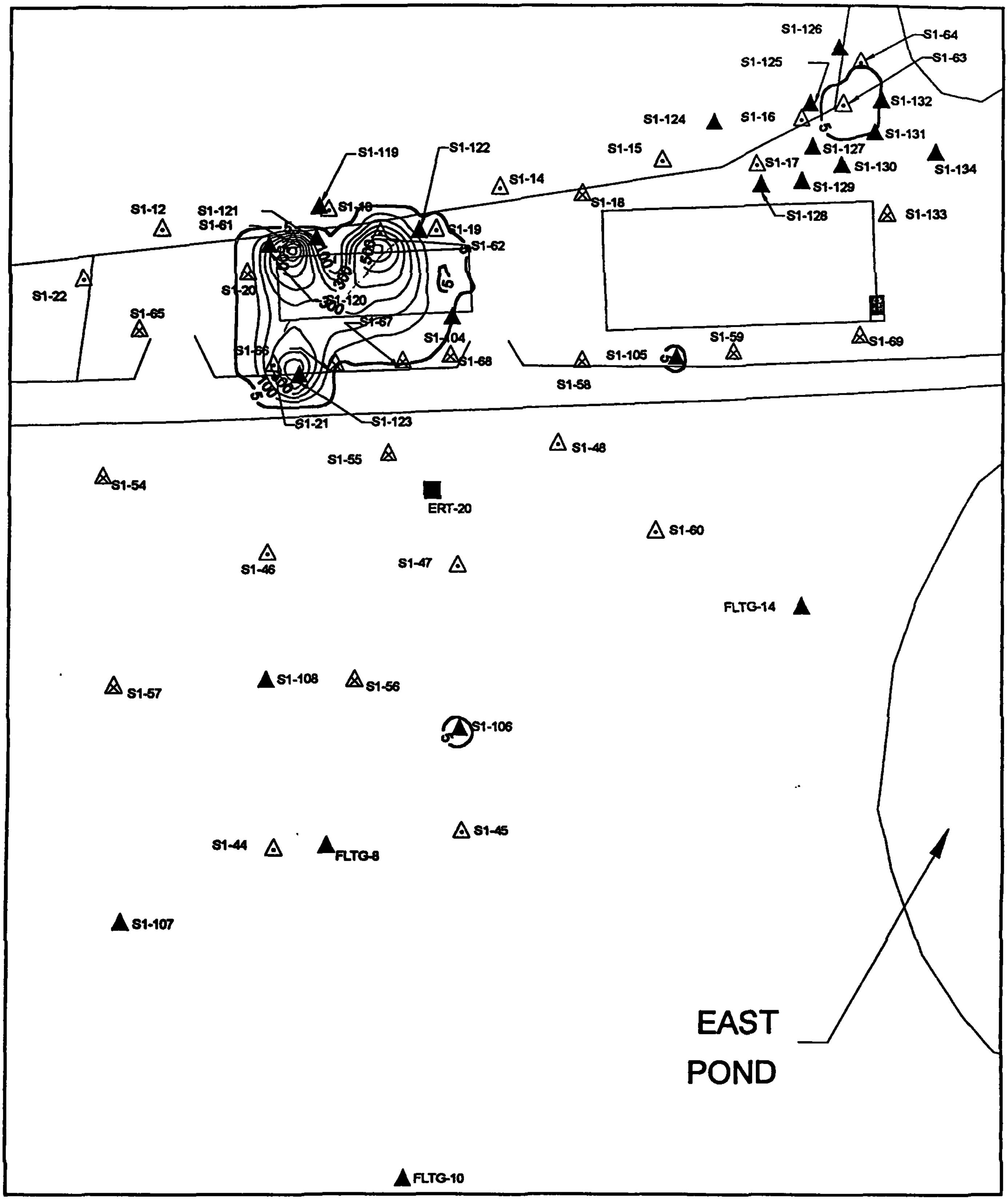


S1 EAST DEMONSTRATION: BENZENE (ppb) YEAR 2005

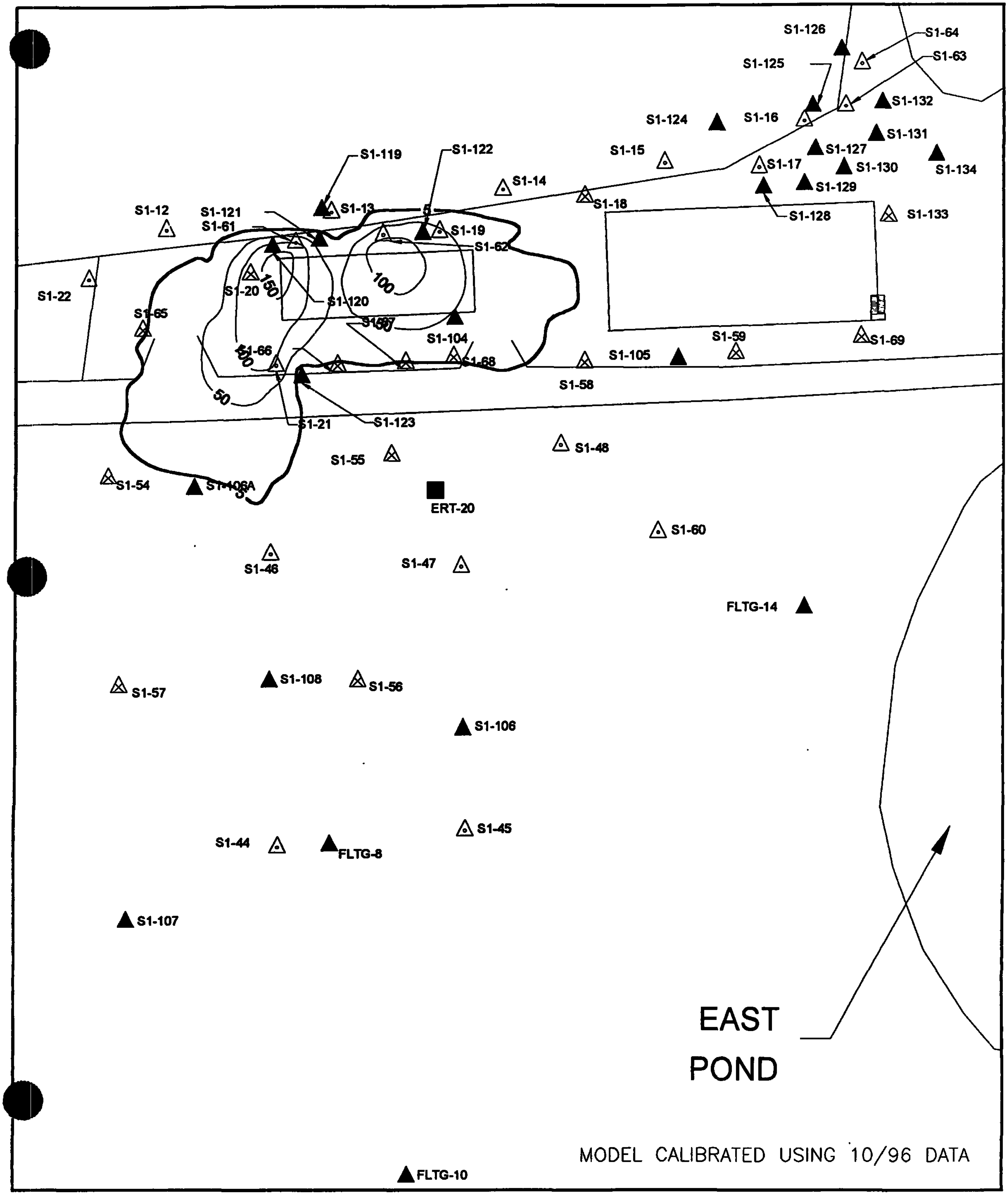


MODEL CALIBRATED USING 10/96 DATA

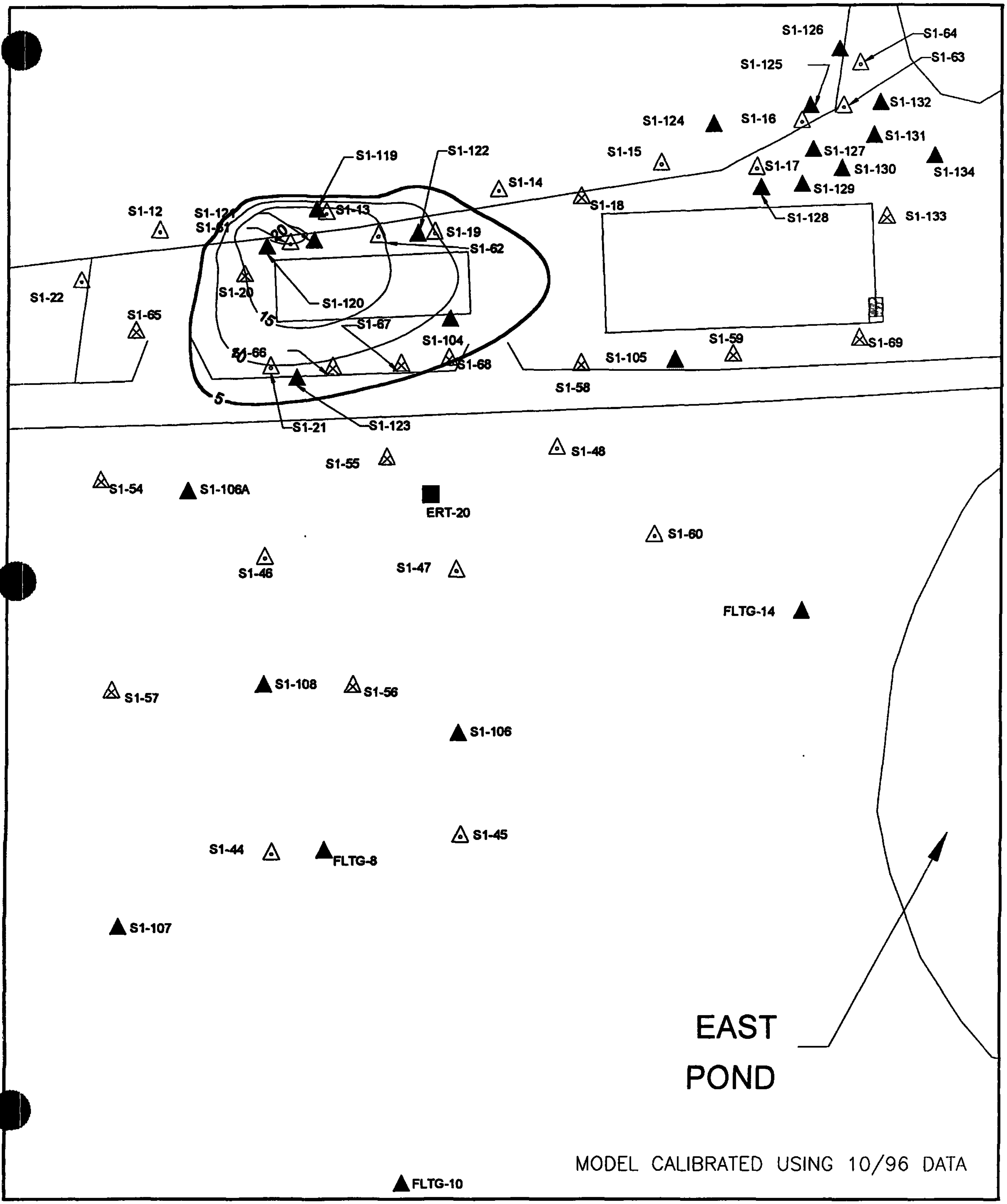
S1 EAST: 1,2-DCA (ppb) INITIAL



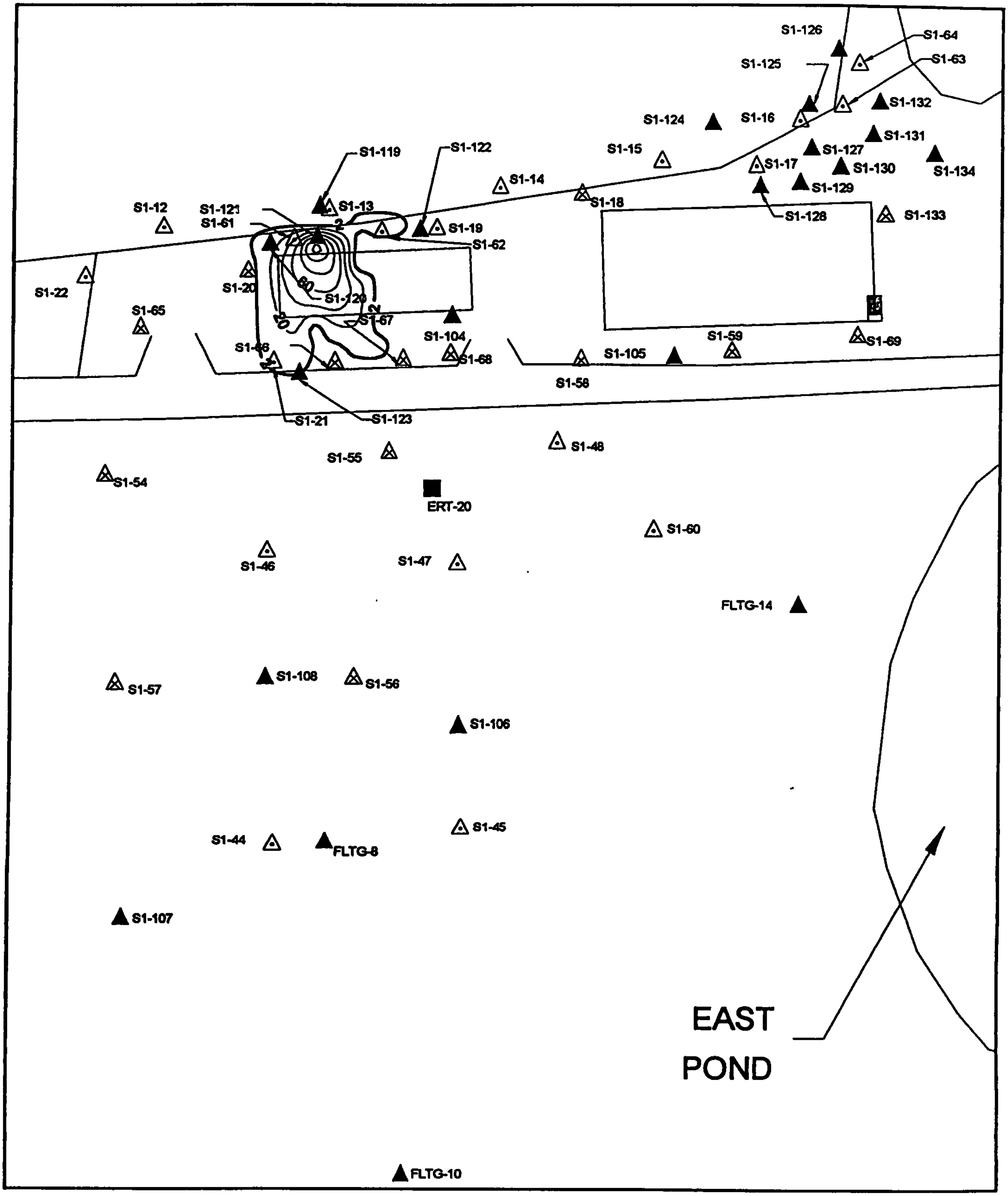
S1 EAST HYBRID DEMONSTRATION: 1,2-DCA (ppb) YEAR 1996



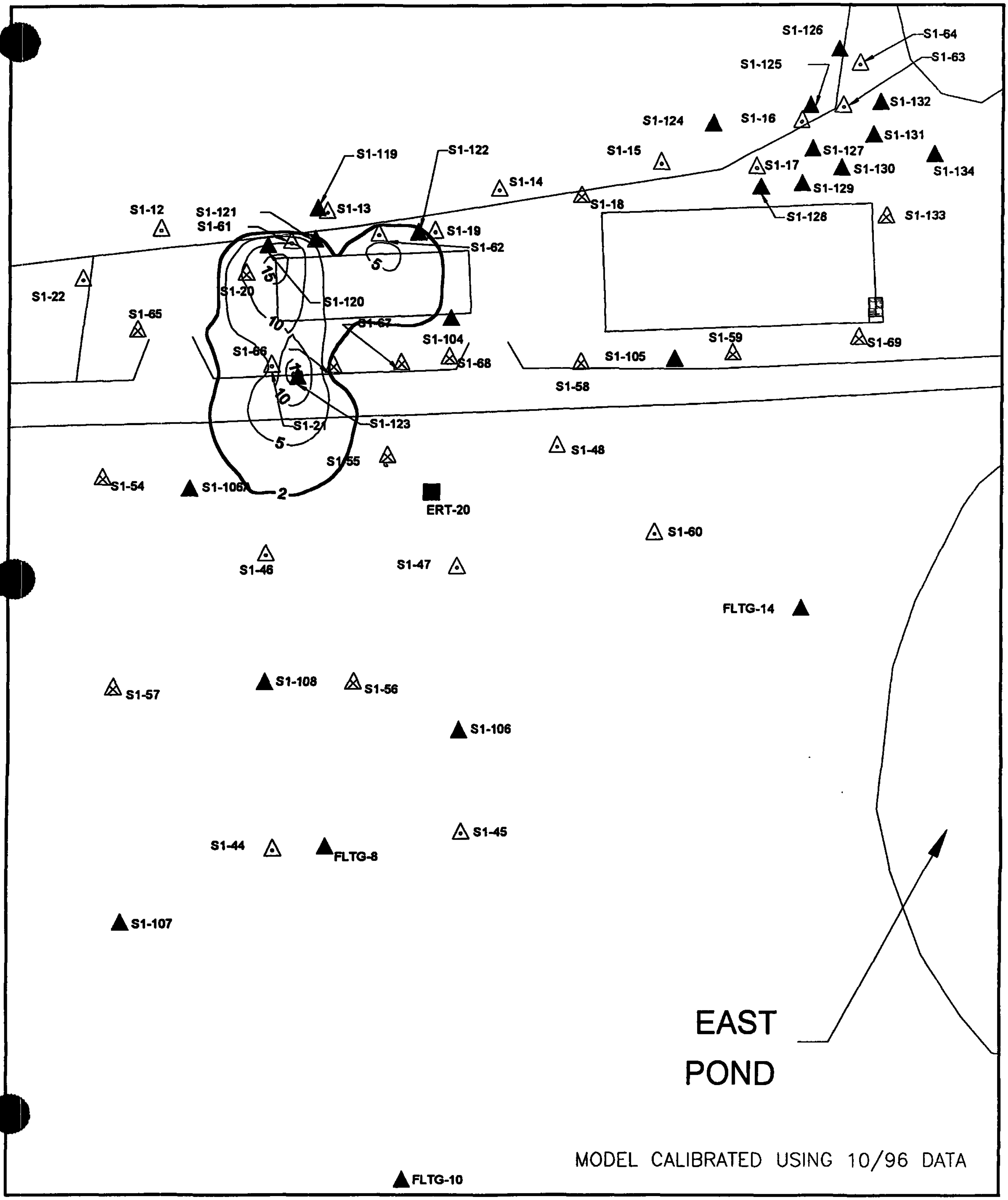
S1 EAST DEMONSTRATION: 1,2-DCA (ppb) YEAR 2005



S1 EAST: VINYL CHLORIDE (ppb) INITIAL



S1 EAST HYBRID DEMONSTRATION: VINYL CHLORIDE (ppb) YEAR 1996



S1 EAST DEMONSTRATION: VINYL CHLORIDE (ppb) YEAR 2005